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JOURNAL

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VOLUME 12, NUMBER 1 • JANUARY, 1956

"Plastics Progress Presents"—SPE's 12th Conference

In Cleveland . . . a view of the Public Square

A TECHNICAL REPORT from Du Pont

• *Properties and application data on "ZYTEL"® nylon resin*

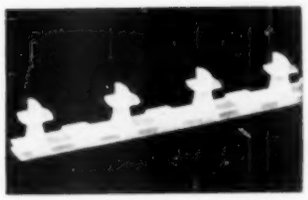
"Zytel" nylon features extreme toughness, abrasion resistance, and form stability at high temperatures. Other properties include strength in thin sections, lightness of weight, chemical resistance, and easy moldability.

Engineers and designers have been able to develop many new design and product improvements by utilizing the unique combination of properties "Zytel" offers. Three typical product improvements are pictured and described at the right. The table below shows the property data for "Zytel" 101 nylon resin, a general-purpose nylon.

For further information on "Zytel," "Alathon" polyethylene resin, "Teflon" tetrafluoroethylene resin, or "Lucite" acrylic resin, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room Du Pont Building, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Utensil holders of "Zytel" don't warp or crack under punishing temperatures of live steam. They cool quickly, resist corrosion.

Clutch facings of "Zytel" nylon resin last five times longer than metal parts which were replaced by these tough, economically molded parts.



Wire supports of "Zytel" take any diameter wire bundle. They're lightweight, won't abrade wire insulation, are impervious to solvents.

MECHANICAL			METHOD
Tensile strength	−70°F.	15,700 p.s.i.	D-638-46T
	73°F.	10,900 p.s.i.	D-638-46T
	170°F.	7,600 p.s.i.	D-638-46T
Elongation	−70°F.	1.6%	D-638-46T
	73°F.	90%	D-638-46T
	170°F.	320%	D-638-46T
Modulus of elasticity	73°F.	400,000 p.s.i.	D-638-46T
Shear strength		9,600 p.s.i.	D-732-46
Impact strength, Izod	−40°F.	0.4 Ft.-lb./in.	D-256-47T
	73°F.	1.0 Ft.-lb./in.	D-256-47T
Stiffness	73°F.	200,000 p.s.i.	D-747-48T
Flexural strength	73°F.	13,800 p.s.i.	D-790-45T
Compressive stress at 1% deformation		4,900 p.s.i.	D-695-44T
Creep in flexure		90	**
Hardness, Rockwell		R 118	D-785-48T

THERMAL		
Flow temperature	>480°F.	D-569-48
Coefficient of linear thermal expansion per °F.	5.5×10^{-5}	D-696-44
Thermal conductivity	1.7 B.T.U./hr./sq.ft./°F./in.	—
Specific heat	0.4	—
Deformation under load at 122°F. and 2000 lb./sq.in.	1.4%	D-621-48T
Heat-distortion temperature		
264 lb./sq.in.	150°F.	D-648-45T
66 lb./sq.in.	360°F.	D-648-45T

ELECTRICAL			METHOD
Dielectric strength, short-time		385 V./MIL	D-149-44
	step by step	340 V./MIL	D-149-44
Volume resistivity		4.5×10^{13} OHM-CM.	D-257-46
Dielectric constant,	60 cycles	4.1	D-150-47T
	10^3 cycles	4.0	D-150-47T
	10^6 cycles	3.4	D-150-47T
Power factor,	60 cycles	0.014	D-150-47T
	10^3 cycles	0.02	D-150-47T
	10^6 cycles	0.04	D-150-47T

MISCELLANEOUS		
Water absorption	1.5%	D-570-42
Flammability	self-extinguishing	D-635-44
Specific gravity	1.14	D-792-48T
Average mold shrinkage	0.015 in./in.	—
Compression ratio	2.1	D-392-38
Resistance to weathering	good	—
Basic color	light cream, translucent	—
Resistant to:	esters, ketones, common solvents, alkalies, weak acids	
Not resistant to:	phenol, formic acid, concentrated mineral acids	

Some of the physical properties are dependent on the moisture content of the nylon which may be as high as 2-2.5% under normal exposure.

**Term "creep in flexure" is a measure of the deformation under a prolonged standard load. Results here represent mils deflection in 24 hrs. of a 1/8" x 1/2" bar, 4" span, center-loaded flatwise to 1,000 lb./sq. in., minus the initial deflection.

NOTE: This table shows the typical property data for Du Pont "Zytel" 101 nylon resin. These values should not be used for specification purposes.

ZYTEL	ALATHON®	TEFLON®	LUCITE®
nylon resin	polyethylene resin	tetrafluoro-ethylene resin	acrylic resin

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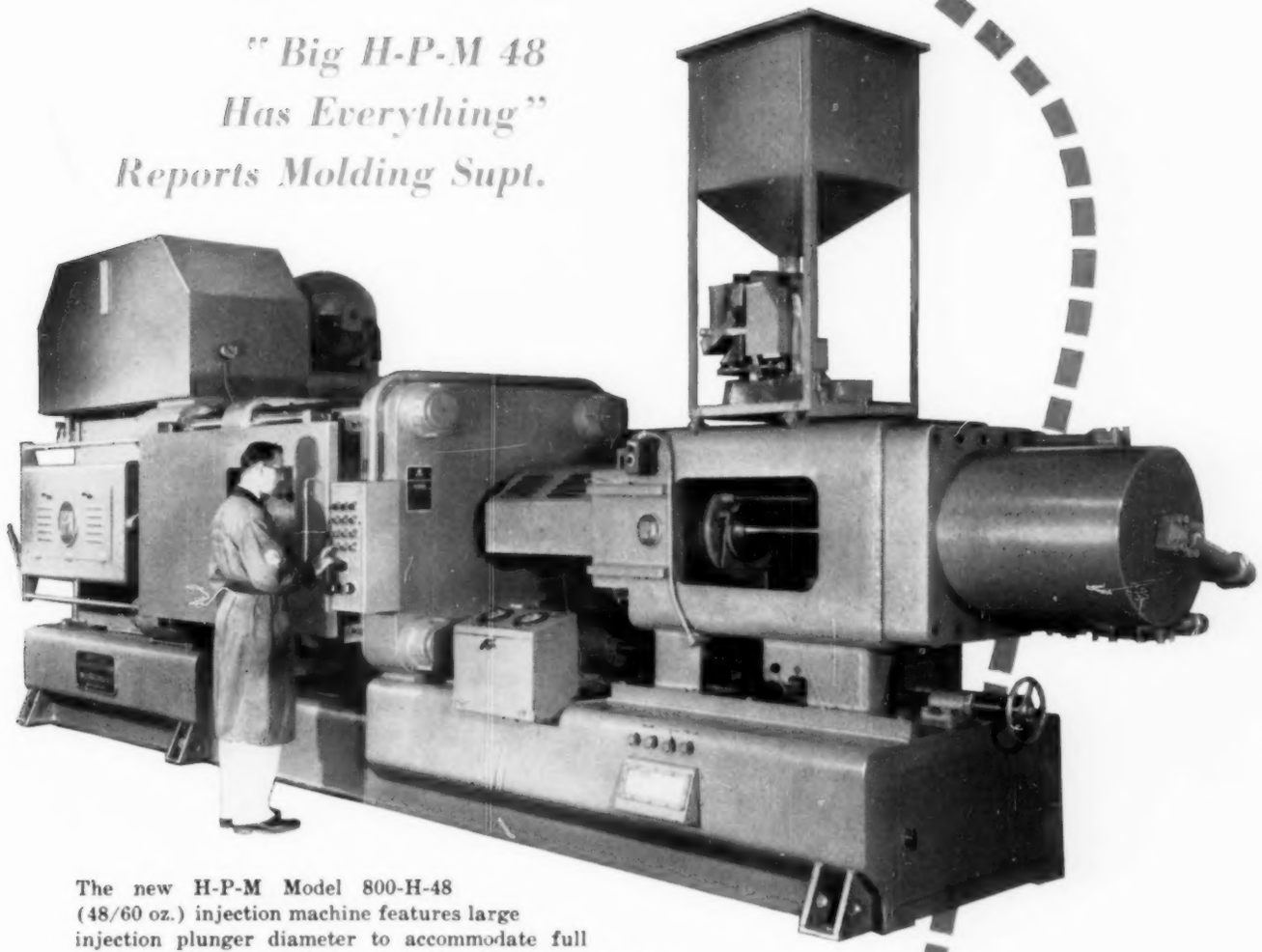
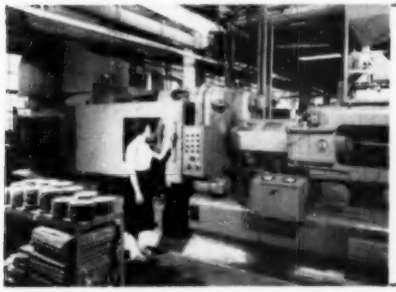


The new H-P-M Model 800-H-48 (48/60 oz.) injection machine features large injection plunger diameter to accommodate full capacity polyethylene shots . . . plenty of stroke . . . large mold area. It's fast and rugged with straight line hydraulic mold clamp . . . high injection speeds . . . and plasticizing capacity for the "big" shots at speeds never before possible.



Andy McKelvey, Molding Superintendent at American Molding Products, Chicago, says, "Our H-P-M 48 oz. is a honey. It has everything a molder could ask for in an injection molding machine."

There's an H-P-M for every plastic molding requirement . . . Injection . . . Compression . . . Transfer . . . reinforced Plastics . . . Laminating. Write for complete information today.

HPM

PLASTICS DIVISION

THE HYDRAULIC PRESS MFG. CO.

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U.S.I. POLYETHYLENE PROCESSING TIPS

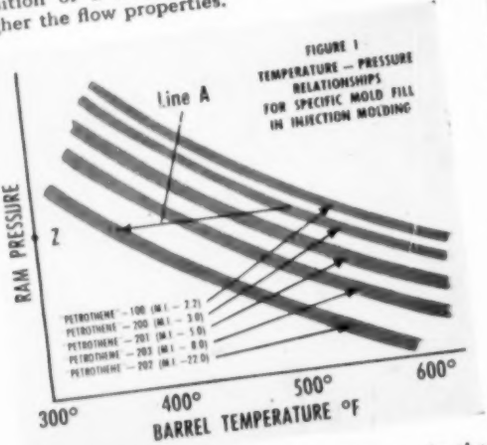
Increase production rates by choosing the right resin

Choice of the polyethylene resin with flow properties best suited for a particular application can make the difference between high or low profit to the injection molder.

Which is the *best* resin? This of course will vary from application to application, but here is some background information that will help you find the right answer for *your* application.

The curved bands in Figure 1 represent injection molding conditions for resins exhibiting several different flow properties. The lower the position of a resin's band on the graph, the higher the flow properties.

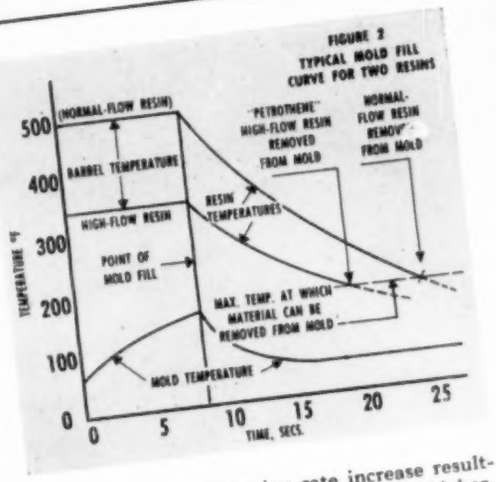
FIGURE 1
TEMPERATURE — PRESSURE RELATIONSHIPS FOR SPECIFIC MOLD FILL IN INJECTION MOLDING



These curves show that a molder can do the same molding job at a *lower* barrel temperature — without increasing his ram pressure — simply by going to a higher-flow resin. Line A, for example, shows that the job can be done at pressure Z with PETROTHENE® 200 at 500°F barrel temperature, can be done with PETROTHENE 201 at 470°F, PETROTHENE 203 at 430°F, or PETROTHENE 202 at 370°F.

What does this mean in terms of cycle time and production rates? Refer to Figure 2, which shows typical cooling curves for an injection molding cycle at two different barrel temperatures. The curve shows that the "normal-flow" resin, operating at a barrel temperature of 500°F in this particular mold, takes 25 seconds to reach release temperature, while the "high-flow" resin reaches this same temperature level in 21 seconds — a saving of about 16% in cycle time. Of course, these times and temperatures apply only to this particular mold. Other molds will have greater or lesser savings, but the same general principle applies.

FIGURE 2
TYPICAL MOLD FILL CURVE FOR TWO RESINS



Aside from the production rate increase resulting from this cut in cycle time, the use of higher-flow polyethylene resins has other advantages — 1. Higher surface sheen, 2. Lower warpage, 3. Less shrinkage.

One caution. When using high-flow resins, be sure that there is adequate back-pressure to eliminate the possibility of air voids appearing in the molded part.

Plant performance tells the story

Molders who have been using U.S.I.'s PETROTHENE 202 (Melt Index — 22) for molding large-size housewares report production increases of *as much as 35%*. Other high-flow types of U.S.I. PETROTHENE — types 201 and 203 — have been chosen because they give the desired degree of flexibility to the molded part, as well as for the production increase.

Call on U.S.I. technical service

Because there's no single answer to all molding and extrusion problems, each has to be tackled individually. U.S.I. Technical Service Engineers are ready to work with you toward the solution of any of your polyethylene processing problems.

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SPE JOURNAL

Vol. 12 January, 1956 No. 1

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• *Entered as second-class matter at the Post Office at Athens, Ohio.*

Donald A. McQuarrie, '58 of Lowell, enrolled in the plastic engineering course at Lowell Technological Institute, Lowell, Mass., has been awarded the first scholarship for plastics study established in the country by the Society of Plastics Engineers, Inc. He is presented a check for $200 by Harry Connors of Boston, president of the Eastern New England section of the S.P.E. Left to right are LTI Dean of Faculty Charles F. Edlund; Alfred I. Simon, chairman of the S.P.E. publicity committee; Ralph L. Mondano, head of the S.P.E. educational activities committee and treasurer; McQuarrie, Connors, Dr. Russell W. Ehlers, head of the LTI plastics engineering department; Dean of Students Richard W. Ivers.

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12 BENEFITS OF

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2. *Carry more* **LOADING** – due to its fluidity when hot.
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4. *Speed up* **VULCANIZING** – by its fast cure and vulcanizing effect.
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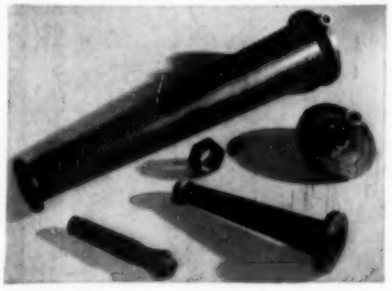
6. *Increase* **STIFFNESS** – through its natural cured rigidity.
7. **REINFORCE** – with increased tensile strength.
8. *Step up* **WEAR** – it improves abrasive resistance.
9. *Withstand higher* **HEAT** – by its inherent heat resistance.
10. *Add* **CHEMICAL** *resistance* – by its natural resistance to solvents and chemicals.
11. *Produce* **GLOSSY** *finish* – another inherent resin property.
12. *Add* **WATER** *resistance* – by its resistance to water and oxidation.



● Molded parts for many purposes give better service when compounded of nitrile rubber with Durez resin.

Important new areas of usefulness are open to hard and semi-hard nitrile rubber compounds when these contain Durez phenolic resins. We list 12 benefits conferred by these resins as reported by rubber producers . . . four in processing and eight enhanced properties available in end-products. You are invited to use our many years of experience with the thermosetting phenolics in investigating their value for your business.

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"Leaders in phenolic plastics"

Indexes to the SPE Journal for 1954 and 1955

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Accessory Equipment for Quality Molding—by W. E. Rahm—Page 20—May

Acrylonitrile Copolymer Blends in Pipes and Fittings—by Paul M. Elliott—Page 26—May

Adiabatic Extrusion of Polyethylene—by J. M. McKelvey and Ernest C. Bernhardt—Page 22—March

Applications for Rubber Modified Molding Compounds—by Edwin V. Hellyar—Page 34—May

Arcing Tests on Plastics—by Thomas J. Martin and Raymond L. Hauter—Page 13—February

Automatic High Speed Injection Molding—by Ernest P. Moslo—Page 12—May

Automatic Production Equipment for Resin Mixes—by Marvin Schneider—Page 22—September

Bag Molding—by D. L. Ridenour—Page 35—December

Better Plastics Products with Statistical Quality Control-Introduction—by L. M. Debing—Page 19—September

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Future Growth of the Plastics Industry—by H. A. Gadd—Page 68—June

Heat Flow Through Plastics Materials—by Victor Paschkis—Page 28—November

High Impact Polystyrene Sheet—by F. J. MacRae and W. D. Harris—Page 22—May

Industrial Interest in the Education of the Plastics Engineer—by Robert C. Bartlett—Page 21—June

Liquid Polymers Combined With Epoxy Resins—by J. S. Jorczak and J. A. Belisle—Page 23—February

Measurement of Creep of Acrylic Glazing Plastics Exposed to Temperature Gradients—by M. C. Slone and F. W. Reinhart—Page 29—December

The Mechanical Properties of Polyethylene—by Robert H. Carey—Page 16—March

Plastics and the Industrial Designer—by Jean O. Reinecke—Page 12—January

Plastic Auto Body Developments—by W. A. Hermonat—Page 31—November

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Abstracts of the Conference Papers

—Twelfth Annual Technical Conference—

Cleveland, Ohio—January 18-20—Statler Hotel

A New Measure of Plastics Moldability—Don B. Semeyn—The Dow Chemical Company.

This paper deals initially with the problems of moldability and methods of measuring, followed by a description of a specially designed mold, molding cycle and unit of measure to more precisely define characteristics of moldability.

Internal Fin Type Injection Moldi[illegible] Heating Cylinder—Mario Maccaferri; Mastro Plastics Corp.; R. B. McKee; The Dow Chemical Co.

This heating cylinder, having no internal spreader, depends upon internal fins for heat transfer surfaces and forces the melted plastic through small holes into longitudinal grooves which direct it towards the nozzle. Two tested designs and one in progress are discussed as well as heating test results, dimensional accuracy, and heat distortion resistance on molded articles, and compared to heating cylinders of conventional design.

A Photographic Study of Injection Molding Polyethylene—R. W. Miler, M. O. Tessin, C. E. Bever—The Dow Chemical Co.

By means of a specially constructed glass sided mold, the flow characteristics of polyethylene when injection molded provides a better understanding on plastic flow, jetting, cooling, shrinkage sink marks, etc. Various phases of molding are shown by movie film record, to indicate further improvement of material, machines and technique.

Automatic Injection Molding of Thermoplastic Insulators for Automotive Electrical Terminations—Donald H. Lewis, Packard Electric Division. Gen. Motors Corp.

The problems of automatic molding of thermoplastic wiring harness terminal insulators and recommendations for molding of other parts based on production experience, are elaborated.

Standards for Injection Molding Machines—A. J. de Matteo, Watson-Stillman Co.

A report describing the objectives of the standardization program and the standards themselves as written by the committee of injection molding machine manufacturers under auspices of the SPI in cooperation with the Master Mechanics Committee of General Motors Corp.

Development of An Epoxy Resin Potting Compound and A Potting Mold for Precision Pottings — William H. Crandell, Frederick S. Bacon Laboratories.

Epoxy resins, fillers and hardeners in various formulas are discussed in relationship to the problem of producing a potting compound and mold for precision pot-

(Please turn to page 8)

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Abstracts of Conference Papers

(Continued from page 7)

tings of microsyn stators for gyroscope use.

Long Term Strength Properties of Reinforced Epoxy Pipe — H. D. Boggs, Fibercast Corp.

Factors such as surface chemistry directed towards adhesion and relation of environmental effects on tensile, elastomeric characteristics, etc., are presented as well as description of testing procedures, and the relationship of glass structures versus design.

Epoxy Base Adhesives In the Aircraft Industry — M. Bandaruk, Convair, Fort Worth, Texas.

The use and development of epoxy resins and combinations of resins for effecting durable, high strength bonds as metal to metal and metal to core adhesives. Discussion of epoxy resin adhesives, requirements, advantages and increasing use in aircraft design and assembly.

house Electric Corporation.

Epoxy Resins In Plastic Tooling — T. R. Sparrow, Republic Aviation Corporation.

The advantages and disadvantages of epoxy resins in plastic tooling are presented. The effectiveness of various epoxy formulations and methods of tool manufacture are evaluated from a practical engineering view point.

The Effect of Explosions On Plastics — H. A. Perry, Jr., Naval Ordnance Laboratory.

Test specimens molded in conical form are studied as to fracture, flow, energy absorption and transmission of shock waves when subjected to explosive shocks. Effects of types and methods of reinforcement are discussed.

Abstract of "The Determination Of Fracture Temperature Of Embedment Castings" — Leonard S. Buckoff, Westinghouse Electric Corporation.

A method for the determination of thermal shock resistance of embedment castings is described by establishing a time temperature curve and temperature of break obtained from resistance readings then magnet wire wrapped around hex bar before casting.

Service Temperature Characteristics Of Molded Acrylic Parts — J. J. Gouza, E. N. Robertson, Rohn & Haas Company, Bristol, Pennsylvania.

Data on strength properties versus temperature and modulus of elasticity versus time and temperature are presented for two acrylic compositions as per ASTM D 988-48T Grades 6 & 8. The influence of molded in stresses & effect on crazing resistance are discussed.

Application Of Radiation To the High Polymer Field — D. S. Ballantine, Brookhaven National Laboratory, Union, L. I., N. Y.

The effects of radiation on polystyrene, nylon, acrylics, polyethylene and other plastics are discussed, with particular references to the effect of and properties obtained from radiated polyethylene. A variety of graft copolymers have been produced by the irradiation of polymers in the presence of a monomer.

The Utility Of Impact Testing As A Criterion Of Toughness — C. H. Adams, G. B. Jackson, R. A. McCarthy, Monsanto Chemical Company.

A discussion which includes limitations of accepted evaluation techniques used to estimate toughness of styrene rubber molding materials. Using a variety of shock loading techniques, a more meaningful test is developed, wherein impact is accurately measured & related to performance.

Compression and Transfer Molding Of Guided Missile Plastics Parts — W. R. McGlone, L. B. Keller, Hughes Aircraft Company.

A description of requirements, design and construction of molds and construction of molds and formed parts for plastic components. Aerodynamic, & electrical properties, precise dimensional control and other special considerations that pertain to guided missiles are advanced.

Engineering Of Purchased Molds — J. C. O'Brien, Shaw Insulator Company.

Ways and means, suggestions and illustrations are brought out to assist the molder and mold supplier cooperate for the benefit of quality of product and promote good business practices through coordination.

The Effect Of Heat Treatment On the Polishability Of Mold Steel — E. E. Lull, Crucible Steel Company.

A report on investigations of mold steels indicating best samples were representative of lower temperatures than those normally associated with carburizing and deducing further, that good polishability is related to the absence of retained austenite.

Advantages Of Cast-In Electric Heaters — W. H. Norton, Thermel, Incorporated.

Advantages as to gradient, efficiency, controlability, life factors and capacity are pointed out with relation to the extrusion of a number of plastics and factors which required the conversion of other forms of heating to electric cast heaters.

Stepless and Three Position Temperature Controls On Extrusion Equipment — R. K. West, West Instrument Corporation.

A presentation of new instruments and methods to extend the scope of accurate temperature control on extruders and provide ways and means of regulation to assure control of the many variables that are encountered in extrusion processes.

Plug Assist Forming — A New Sheet Fabrication Technique — J. W. Mighton, Dow Chemical Company.

The technique of plug assist affords easier fabrication and widens scope of small and large articles when vacuum formed. The advantages, problems and examples are discussed showing better uniformity of wall thicknesses and adaptability to conventional vacuum equipment.

Fabrication Of Large Area Stretch — Oriented Acrylic Sheet — Alfred Batzdorff, Rohm & Haas Company, Bristol, Pennsylvania.

The technique, machinery and possibilities of stretching acrylic sheet from commercially available sheet to large, unspliced sheet are reviewed as well as suggesting designs for a production type semi-automatic machine.

Rigid Sheet Plastics — Processing and Preparation — C. K. Henry, Celanese Corporation.

A Cellulose acetate and polyethylene fabricated by press type and vacuum forming are discussed and graphically shown by sound and color movies.

Measuring the Effect of Plasticized Vinyls On Impact Polystyrene — R. R. Dixon, Westinghouse Electric Corporation.

By stressing polystyrene in contact with vinyl compounds for a given temperature and time, a quantitative

(Please turn to page 10)

Craftsmen of the 20th Century

No. 10 of a series to introduce you to some of industry's outstanding plastics craftsmen

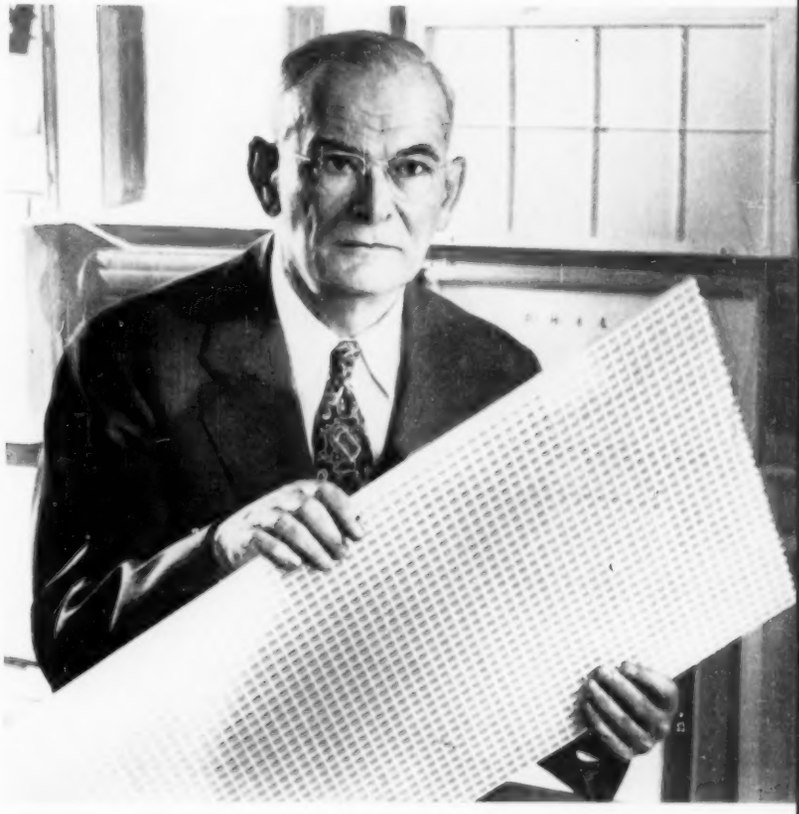
This advertisement is reprinted from the December issue of Dun's REVIEW AND MODERN INDUSTRY, where it was seen by more than 118,000 business leaders.

Famous artisans of bygone days applied their talents to precious metals. Others worked wonders with common materials like iron and wood and stone. New materials are now at hand to capture the imaginations and challenge the skills of contemporary craftsmen. These modern materials are the fabulous family of plastics.

Pictured here are two of the molders who are devoting their lives to crafting plastics into mass-produced articles that can serve every industry, every home. Monsanto, a major producer of high-quality plastic materials, salutes these craftsmen who are helping to mold America's tomorrow.

When your plans call for plastic parts or products, consult an expert custom molder

Robert D. Buzzee, Plastics Dept., General Electric Company, Decatur, Ill. After serving as a G.E. Product Engineer and a Tool Design Engineer, Mr. Buzzee is currently Supervisor of Manufacturing Engineering. Typical plastics applications he has engineered include a soft drink syrup dispenser valve body assembly, a six component fixed focus 35mm camera, and a portable kit involving ten plastics parts for making dry ice from carbon dioxide. Mr. Buzzee emphasizes to end users the importance of optimum product design for plastics applications by experienced engineers.



C. Edgar Maynard, Prolon Division, Pro-phy-lac-tic Brush Co., Florence, Mass. As operations manager for his division, Vice-President Maynard has pioneered progress in custom molding since 1943. His company specializes in the design, development and production of custom molded parts for air conditioners, refrigerators, radios, television sets and electronic equipment. Mr. Maynard has made valuable contributions to plastics technology which have helped form the high standards of the industry, holding many patents on injection molding machines and processing methods.

MONSANTO CHEMICAL COMPANY,
PLASTICS DIVISION, SPRINGFIELD 2, MASS.

MONSANTO

LUSTREX
Styrene Plastic

Abstracts of Conference Papers

(Continued from page 8)

effect may be measured in a few hours, by measuring the resultant flexural strength of the polystyrene.

Characteristics Of Biaxially Stretch Oriented Acrylics — D. A. Hurst, Rohm & Haas Company.

Data are presented to show temperature versus rate of stretching out their effect on crazing resistance and impact strength.

Flow Behavior Of Phenolics Under Molding Conditions — D. I. Marshall, Bakelite Company.

Yield values, & rate of mold fill-out are determined and discussed with respect to flow behavior, including changes during hardening.

Plasticity As A Tool In Resin Development and Formulation — George P. Rowland, Jr., Resin & Chemical Development Laboratory, Firestone Plastics Co., Pottstown, Pa.

A modified plate plastometer utilizing a ½ gram sample of raw resin is described and translated into information on molecular weight, conversion during polymerization, softening point and processing latitudes of formulated compounds. Differences in plasticity and moldability as well as examples are shown to relate to fabricating conditions.

Physical Properties Of Unmodified Rigid PVC — Frederick W. Schneider, Firestone Plastics.

The physical properties such as tensile, flexural and compressive strength & moduli, impact resistance, heat distortion, electrical and thermal, are presented and supported by tables and graphs on unmodified rigid PVC.

Injection Molding Research — Today and Tomorrow — Joseph Eveland, Henry J. Karam, Carlton E. Beyer, The Dow Chemical Company, Midland, Michigan.

A paper presenting research information concerning heat fabrication properties of thermoplastics, applied to the improvement of materials, machines, molds and molded products.

"Tensile Impact: A More Meaningful Impact Test" — Chester G. Bragaw, Jr., Du Pont.

A modification of Izod Impact Tester permits evaluation of films and molded tensile bars. Single test can relate rigidity from soft compositions to metals. Indicate correlation of tensile impact strength with use tests.

Problems and Trends In European Extruder Design — The Projeclite & Eng. Co. Ltd., Battersea, London, England.

Comparison of single versus multi screw extruders, advantages and disadvantages of adiabatic extrusion, as well as length diameter ratios on single screw machines are presented in addition to suggestions as to screw designs and screw speeds.

Viscosity Data for Extruder Flow Equations — Robert D. Sackett, Monsanto Chemical Company.

Theory, equipment and test data for determining and applying "apparent extrusion viscosity" are shown with examples such as polystyrene, acetate butyrate, vinyl and styrene-acrylonitrile.

A New Development In Extraction-Extrusion — The Vacuum Extruder Screw — E. C. Bernhardt, Polychemicals Department, Du Pont.

A description of the construction, operation and advantages of a new type of extruder screw which by design, allows volatiles to separate and be subsequently removed on a continuous basis.

Melt Fracture — Extrudate Roughness In Plastics Extrusion — J. P. Tordella, Du Pont.

Melt fracture gives use to spiral, wavy and segmented extrudates and is one of the causes of rough or irregularly shaped extrusions. The elimination of melt fracture and their function of temperature for Zytel, Alathon, Teflon and Lucite are described.

Calendaring Equipment and the Plastics Industry — R. C. Seanor, Adamson United Company.

A paper containing a history of the calendaring techniques & problems, describing present day advancements in precision of rolls and journals, bearings, temperature controls, speed of production and control mechanisms for assuring constant film thickness.

Calendaring of Vinyl Sheeting — E. F. Wuest, Masland Duraleather Company.

The discussion is taken step by step through all processes from raw material to finished sheeting. Pigment grinding, color control, Banbury mixing, milling and calendaring are described in detail.

Spread Coating Techniques — D. G. Higgins, John Waldron Corporation.

Illustrations by slides will present and expand the subject of spread coating techniques as to processes used today and the derivation of new techniques borrowed from paper coating technology.

Plastics Coated Fabrics — E. G. Hanway, General Tire & Rubber Company.

A general discussion of present day materials and techniques used in the manufacture of plastics coated fabrics. Future possibilities are summarized and factors governing growth are set forth.

Non-Glass Reinforcement In Plastics—Johan Bjorksten, Bjorksten Research Laboratories.

A review of the principal types of non-glass reinforcement (cellulose, asbestos, nylon etc.) listing pertenent properties, present and future applications and the development problems of each type.

Practical Evaluation Of Reinforced Thermosetting Molding Compounds — Paul E. Fina, Director of Sales Engineering, Chicago, Illinois.

Choice of resin, fillers and molding properties are to be reviewed as they pertain to more careful selection of materials and processing in properly engineered design of part as well as the mold.

Asbestos Reinforced Plastic Laminates — D. V. Rosato, Raybestos-Manhattan, Inc.

The use of asbestos in various forms and types in plastic reinforcements and their resultant mechanical properties will be technically and graphically presented.

"Reinforced Plastics In the Construction Of External Pressure Vessels" — Robert Barnet, Carroll L. Lloyd, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland.

The characteristics of glass reinforced plastics are determined and the factors related to problems encountered in producing housings capable of resisting extreme external hydrostatic pressures.

(Please turn to page 12)

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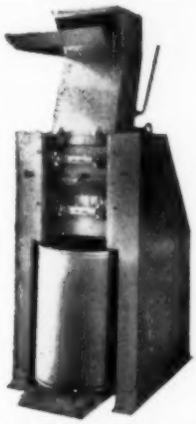

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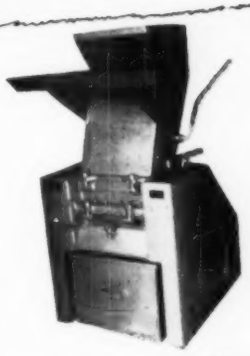

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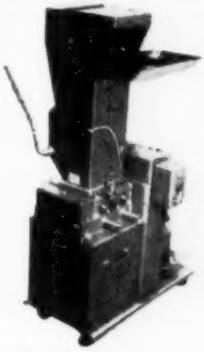

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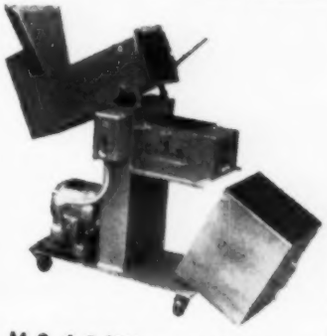

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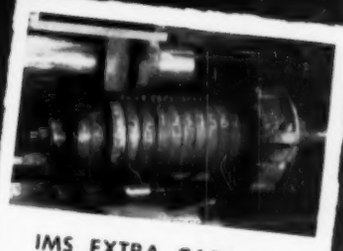

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Abstracts of Papers

(Continued from page 10)

Cellular PVC Plastic and the Chemical Blowing Agent BL-353* — H. E. Arnold, Du Pont.

A non-discoloring, non-staining, vitrogen releasing blowing agent to produce both closed and open cell type PVC foam is discussed, particularly as to formulating processing.

Polyurethane Foams — C. J. Harrington, Du Pont.

A technical presentation of rigid insulating and resilient cushioning polyurethane foams show their present and future applications and properties.

Vinyl Foam — Henry E. Allen, Elastomer Chemical Corp.

A presentation of the growth, present status, and future potentials of the vinyl foam industry. Specifically, pointing out techniques, the Elastomer Process, applications and materials, the paper covers a field of wide scope and of increasing possibilities.

Expanded Polystyrene — Fabrication Methods and Applications — O. R. Franson, The Dow Chemical Company.

Paper will include types of polymer, formulations, expanding agents, fabrication techniques, molding heating & cooling, mold construction and molding cycles.

Butyrate Pipe — Properties and Applications — L. W. A. Mayer, R. J. Scogin, Tennessee Eastman Company.

Additional to the properties, applications and fabrication techniques of Butyrate pipe, test data on long term creep at two temperature levels, impact shrinkage and burst strength properties are reviewed.

"Kralastic Pipe — Tough, Rigid, Chemically Resistant"— Paul M. Elliott, Naugatuck Chemical Company.

Applications, properties and advantages of the acrylonitrile copolymer blend — Kralastic — are presented as well as fabrication techniques and future possibilities.

Rigid Vinyl Pipe — Jean F. Malone, B. F. Goodrich Chemical Company.

A discussion of rigid vinyl pipe market in the U. S. including types used, physical and chemical properties, production methods, followed by an analysis of present and future applications.

The Properties and Uses Of Polyethylene Pipe — Chester O. Bragaw, Jr., Du Pont.

The utilitarian aspects, service experiences and typical pipe creep data are presented on commercial polyethylene. Factors affecting creep fracture, creptallinity, melt index, extrusion variables and solvent cracking agents are reviewed.

Problems Encountered In Tooling World's Largest Airborne Reinforced Plastics Component — N. A. Nicholson, Zenith Plastics Company.

The lower radome for the Super Constellation posed many difficult problems, largely because of its size and complex factors which determined the trend of mold design. Basic mechanical properties of reinforced plastics, control of dimensions & tolerance, distortion, and other factors are considered as well as costs of tooling.

Tooling for Large Radomes — R. H. Vreeland, Hughes Aircraft Company.

The problems and their solution, of die development as to design, fabrication and testing of matched metal dies, are discussed as they pertain to the high pressure molding of laminated fiberglas radomes.

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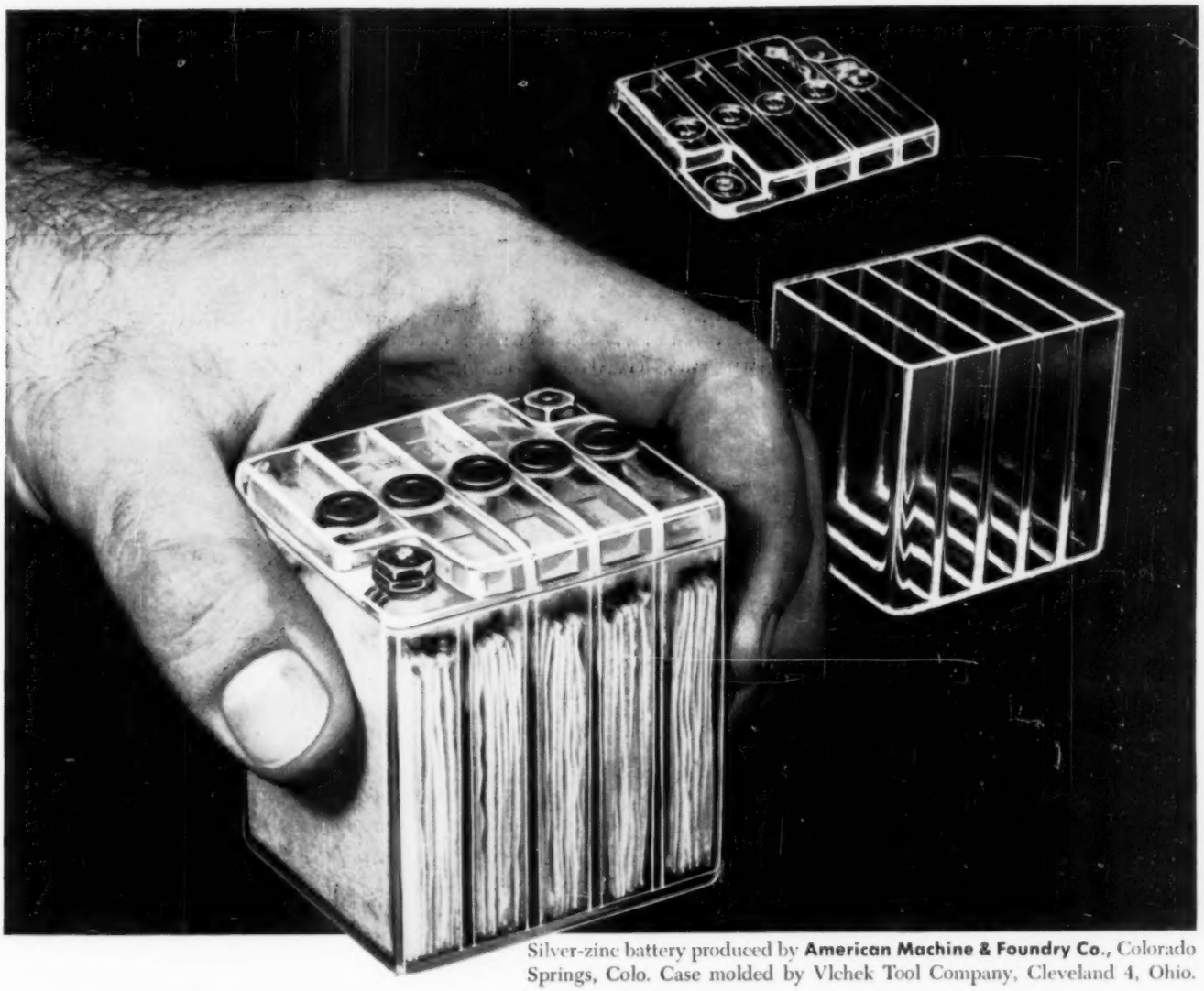

Silver-zinc battery produced by **American Machine & Foundry Co.**, Colorado Springs, Colo. Case molded by Vichek Tool Company, Cleveland 4, Ohio.

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Abstracts of Conference . . .

(Continued from page 12)

"Applications Of Plastics In Marine Cathodic Protection Systems" — M. Stauder, N. S. Preiser, Bureau of Ships Department of the Navy.

Plastics, as components in marine cathodic protection systems, are well chosen. Reinforced, epoxies, rigid PVC, polyethylene and others are discussed and evaluated as to performance.

Fire Resistant Electrical Grade Polyester Laminates — J. K. Allen, Westinghouse Electric Company.

Laminates containing two different fillers are compared using general purpose polyester and chlorinated polyester. Comparisons of burning rates and electrical properties are discussed.

The Effects Of Fabrication On the Properties Of "Teflon" Tetrafluoroethylene Resin.

The control of fabrication conditions permits the molder to obtain various properties of "Teflon" such as flex life, permeability to gasses, stiffness, toughness, tensile and elongation. Molding conditions are presented, their effect and properties discussed in relation to creptallinity, molecular weight and void content of molding. Methods of measuring these physical quantities, descriptions of performing and sintening and techniques for molding inserts in Teflon are described.

"Super-Polyethylenes" — Geo. H. Sollenberger, Koppers Company, Inc.

A discussion of the improvements and possibilities of new applications by the use of super polyethylenes. A comparison of properties and end use between the super and conventional polyethylenes.

Silicone Product Development — Dr. L. E. Weisbecker, Bakelite Company.

A story of the problems encountered in silicone resins and molding materials, outliving the future potentialities as a result of solving the problems of molding properties & cycles.

Cellulose Propionate Molding Powder Forticel — David A. Jones, Celanese Corp. of America.

The availability of propionic acid, as well as improved plasticizers, have made "Forticel" a production reality. Properties and applications are discussed with relation to its use as on injection molding material.

Polyethylene — Past and Future — G. W. Jargstorff, Geo. F. Kirkpatrick, Bakelite Co.

Comparisons of conventional polyethylenes with a selected number of new polymers are made on the basis of properties and applications to old and new fields.

Designing With Transparent Plastics — Alfred M. Blumenfeld, S.I.D., Rohm & Haas Co.

A study and recommended practice in the design problems utilizing clear plastics as compared to problems using opaque materials. Suggested methods to be followed in form, Composition, treatment and a case study of automotive escutcheous.

Definite Specifications for Plastic Materials Of Construction — W. C. Wall, R. E. Brooks, Du Pont.

The establishment of specifications for nylon molding powder is used as an example to show the importance of molecular structure, purity and processing characteristics as they pertain to the necessary quality control during manufacture and subsequent fabrication.

Designing With "Zytel" Nylon Resin — A. J. Cheney Du Pont.

Principles of machine design and properties of "Zytel" nylon resins as considered in design problems are graphically described in terms of strength, deformation, and stiffness properties.

Analysis and Solution of Decorating Problems — Lloyd E. Parks, Logo, Inc.

Procedures for analyzing & solving problems of decorating plastic parts, such as adhesion, gloss failure, dry time, etch heat distortion and film irregularities, are discussed and illustrated by slides.

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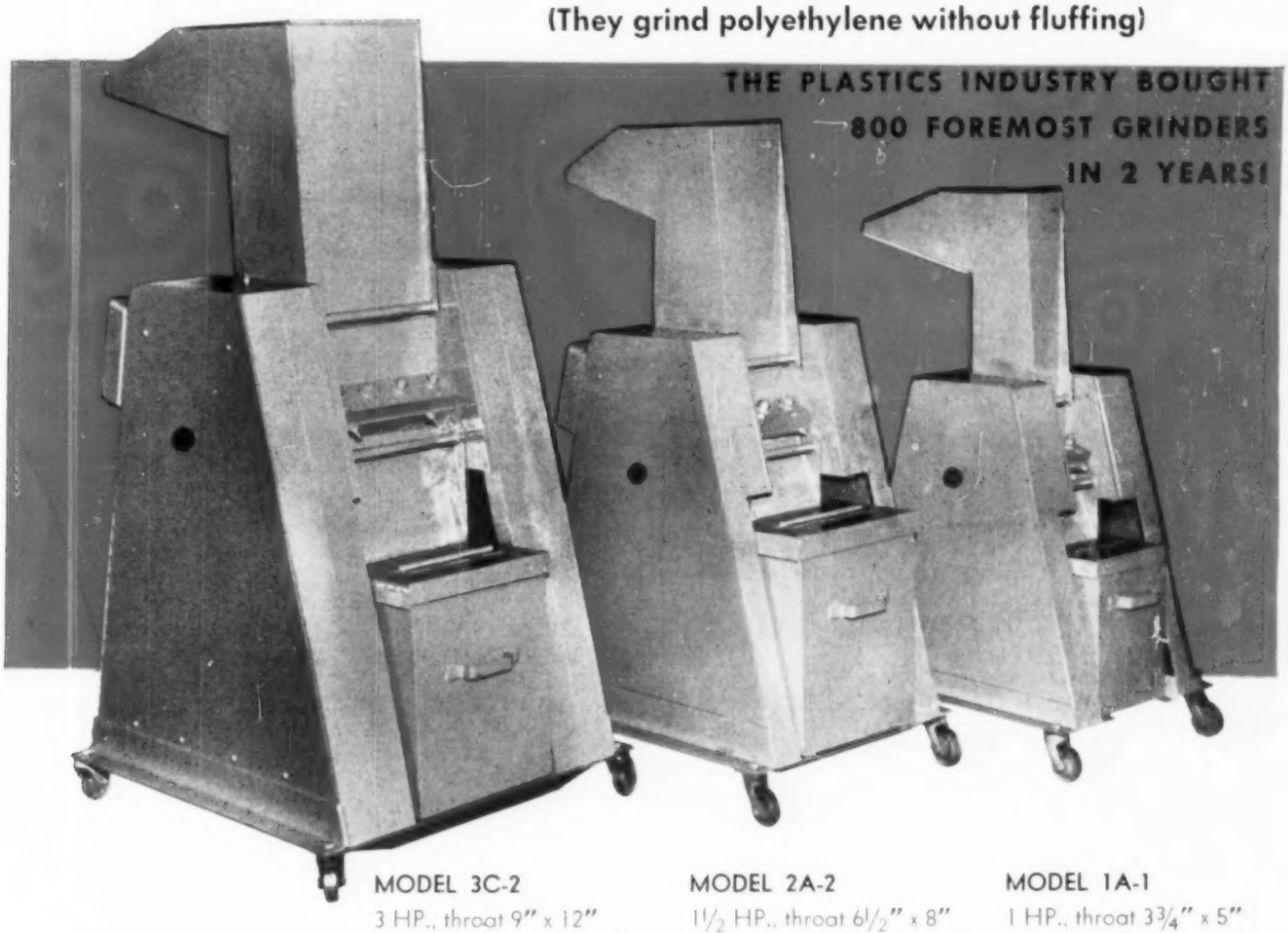

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Will the Polyethylene Gamble Pay Off?—by E. S. Childs—Page 11—October

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Board of Education Appoints M. Martin to Plastics Post

Mr. Maurice Martin, Executive Vice-President of Bassons Industries Corp., has been appointed to the Permanent Advisory Board For Vocational Education of the Plastics Education Committee, Board of Education, New York.

The Board of Education has recognized the growth of reinforced plastics and its important role in industry. The school system is participating in the training of our future plastics technicians. Bassons Industries Corp. have allowed Mr. Martin the fullest cooperation and its research and technical files to aid him in his advisory capacity.

DeBell and Richardson Expands

DeBell & Richardson, Inc., plastics research and development laboratories, have expanded by purchasing the mill and water power of the A. W. Dolge Company adjacent to its present 30 acre site in Hazardville, Connecticut, ten miles south of Springfield, Massachusetts.

The recent acquisition will practically double the present floor space with the addition of 20,000 square feet of working area. This space will be devoted to new chemical and engineering laboratories to relieve strain on the present capacity operations and will provide additional area for pilot plant and pilot manufacturing operations which the concern does in behalf of its clients.

Here's A Job for A Busy Man!

The A.S.T.M. Bulletin frequently carries plastics information of the greatest interest and importance. Would you like to make brief abstracts from the Bulletin for the SPE Journal? No pay except your satisfaction in helping the industry—and free copies of the Bulletin! Write to Jesse H. Day, Editor SPE Journal, Security Bank Bldg., Athens, Ohio.

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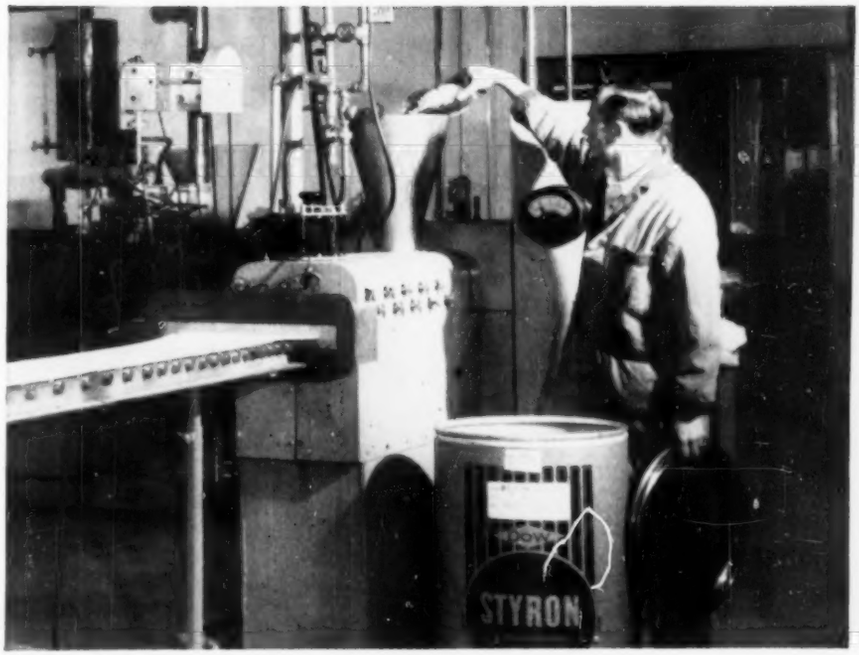

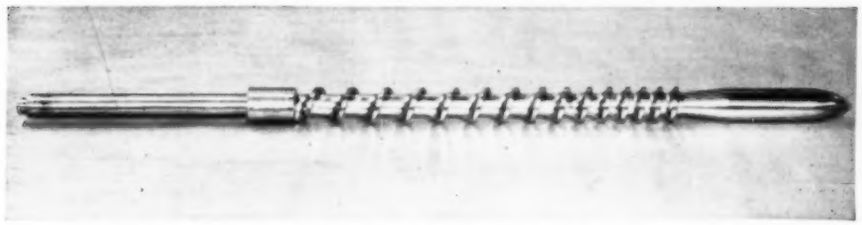

DOW'S STUDIES ON IMPROVED SCREW AND TORPEDO DESIGN HELP MAKE POLYSTYRENE EXTRUSION A MORE EXACT SCIENCE

Studies for the development of a better screw and torpedo from polystyrene extrusion are good examples of Plastiatrics at work. Manufacturers using machines equipped with a single flight screw and torpedo arrangement like this one shown here can profitably extrude high-quality polystyrene and get uniformly good results. One thing that was found in working out the details of this better screw was that single flight eliminates blocking in one channel and flowing in another, a problem of the double flight screw that more often than not produces wide variations in product output.

Further studies of the torpedo have led to extensive findirgs, relative to the use of the torpedo screw, which are available by simply writing Dow.

Standard pressure gage studies another area of Plastiatrics development

Extensive Plastiatrics studies in extrusion have been made on the proper design of dies, take-off equipment and cooling problems. Dow engineers, together with plastics manufacturers, also developed a method for determining optimum pressure and for providing reproducible extrusion performance using a standard gage.

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Detailed results of Dow's studies on extrusion are available to you, as they are on all work done in Plastiatrics. For further information, write today . . . Dow Plastics Sales Department PL 456Z, THE DOW CHEMICAL COMPANY, Midland, Michigan.

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B. F. GOODRICH CHEMICAL COMPANY salutes the members and friends of the Society of Plastics Engineers, all making possible the biggest-ever Annual Conference being held this year in Cleveland.

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Action— By Your National Organization

"The objects of the Society shall be to promote in all lawful ways the Arts, Sciences, and Engineering Practices and Standards connected with the utilization of plastics."

You and the Society

Jerome Formo

The Society of Plastics Engineers is now in the midst of its greatest growth in history. Not only are the usual statistics of members and money reaching new records but even more meaningful results are in the process of being achieved. To enumerate all of these accomplishments in progress would be difficult, but let us look at a few.

The New York Section sponsored the first Regional Technical Conference in November in a manner which will encourage all of the other sections to plan similar Conferences of special interest. The Publications Committee has recently put another of its phases on a professional basis. The Education Committee has completed a revised report on its activities which are unique among engineering societies. Such committees in many other societies serve in a rather desultory fashion but our committee has seen the need of an industry without adequate training facilities and has done something concrete about it.

Similarly, the Professional Activity Committees have taken firm hold of numerous projects including the publication of two books this year and several more to follow. The Technical Advisory Committee and the Joint Technical Societies Committee have served to a greater degree than before, the various National Council Committees have outdone themselves, and the National Office has found itself performing more services for the membership.

But the jobs remaining to be done seem to multiply as the square of our activity. Many people contribute by preparing technical papers for Conferences or for the "SPE Journal," but these generally serve mostly to point out the vast area of unexplored potentials in plastics engineering. This degree of activity of one type or another, if engaged in by only twenty percent of our membership would so boost our industry's status within the next few years that all other industries would sit up and take notice. The day would soon come that not one Journal but perhaps four would be necessary to publish the developments, that not one $2\frac{1}{2}$ day but two 5 day National Conferences would have to be held, that not a 5 person National staff but perhaps 20 would be needed to carry on the functions of the National Office, that not 50 but 5000 individuals would be sharing the load of contributing constructively to the Society's efforts.

Where do you fit into this picture? Are you one of the twenty percent who are anxious to do something. Do you face the question of not knowing how you can help? If so, you can have an answer soon if you will write to the National Office giving a brief description of your work, your interests, your opportunities. The Executive Secretary can then notify the proper activity or committee of your interest.

And these interests can be in any field of plastics ranging from basic polymer mechanics to legal problems involving plastics engineers. Processing, fabricating, designing, testing, and servicing in fields such as molding, extruding, forming, bonding, coating, etc. are only a few examples. Related problems such as education, registration, professionalism, publications, public relations all require work.

Your opportunity to serve your Society is an opportunity for the Society to serve you. Write today to offer your services. After all, **you are the only person in the world** who can do that.

Mr. Formo is the National Director of the Upper Midwest Section of the Society, Assistant Administrator of the Professional Activity Committees and Chairman of the PAC Special Technical Projects Commmittee. He is with the Minneapolis - Honeywell Regulator Company where he is Director of Plastics Research.

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Industrial Applications for Dispersions of . . .

Vinyl Resins

R. L. Norum
Bakelite Co.

DISPERSIONS BASED ON vinyl chloride and vinyl chloride-vinyl acetate resins offer simple, unique and economical advantages in the fabrication of many new and diversified industrial products. These relatively new concepts of dispersion application have evolved principally through the combined efforts of paint chemists, design engineers, basic material manufacturers and fabricators of the finished product. Before discussing specific applications of these versatile materials, however, a brief description of vinyl resin dispersions is in order.

Vinyl Dispersions

Vinyl resin dispersions are suspensions of finely divided resin particles in suitable organic media which do not dissolve the resin at room temperature. A dispersion in which the liquid phase consists entirely of plasticizer is known as a "plastisol." When the dispersing liquid contains volatile components, the dispersion is termed an "organosol." Plastisols can be converted to organosols by diluting with a volatile thinner. The addition of certain gelling agents will convert a plastisol into what is called a "plastigel." Plastigels can be shaped cold and will retain intricate molded detail during the fusing operation.

All vinyl resin dispersions must be baked in order to fuse to a tough resilient form. These fusing temperatures range from 275° to 400° F. The fusing time depends upon how quickly the resin dispersion can be brought up to the fusing temperature. As soon as the fusing temperature is reached, the product can be removed from the heat source.

The resins used in vinyl dispersions are polymers of vinyl chloride, or copolymers in which vinyl chloride is the major component. Commercially available resins range in particle size from 0.02 microns to 2.0 microns in diameter. Resins of smaller particle size are generally used in organosols. These compounds must be milled to disperse the resin and reduce particle agglomeration. This is generally done in ball or pebble mills to minimize the possibility of thinner evaporation. In the preparation of plastisols, certain resins also require milling though other resins can be "stirred-in" by means of pony or dough mixers. For certain applications, "stir-in" resins may be further refined by three-roll milling.

Vinyl resin dispersions are composed basically of resin, plasticizer, stabilizers, and, in the case of organosols, volatile thinners. Since vinyl resins tend to decompose at elevated temperatures or upon prolonged exposure to ultra-violet light, the inclusion of light and heat stabilizers is necessary in order to minimize this reaction. Pigments, fillers, dyes, and other modifiers, as determined by the end use, can be dispersed with the resin or added at a later point as a dispersion in part of the plasticizer. All components must be selected carefully with the intended use in mind. Of the basic materials, the quantity and type of plasticizer, next to the resin itself, have the greatest influence on both the application characteristics of the vinyl dispersion and the final properties of the product.

Machine Mounting Pads

These dispersions can be applied, depending on the type, by most standard methods. Spraying, dipping, tumbling, molding, casting, and knife or roller coating all have been used successfully. One of the more recent techniques developed is the pressure molding of machine mounting pads based on plastisols. In this process, patented by Clark-Cutler-McDermott Company, a vinyl resin-based plastisol is used as a binder for cork and woven sisal mat to produce a mounting pad that requires no cementing or bolting. A crosshatch design, which gives 451 inches of gripping edge per square foot of pad, is surface embossed during the simultaneous molding and fusing operation. These pads have a shape recovery of 99 per cent after sustaining a load of 1000 pounds per square inch, and, under actual operating conditions, have withstood pressures up to 4000 pounds per square inch.

Down time for the adjustment of machinery is minimized by the use of these plastisol-based pads. In one case, reported by the user, textile coning machines formerly required frequent adjustments because of misalignment due to vibration. The use of these pads has permitted 6 months' operation without the need of machine realignment. This reduction of vibration by the plastisol-bonded mounting pads has also resulted in a 20 per cent increase in speed efficiency. An additional advantage is that, since no bolting or cementing is necessary, much greater flexibility in the layout of the plant machinery is possible.

Vinyl resin-based plastisols were selected for this application because of the inherent properties of the vinyl resin and the relative ease of applying the dispersion. Properly formulated vinyl resin-based plastisols are resistant to oils, greases, alkalies, acids, water, soap, and detergents. Thus these mounting pads, by virtue of the vinyl resin used, will withstand most of the deteriorating materials commonly found in an industrial plant.

Flexible Molds

The controllable resilience of products based on plastisols has resulted in another unusual application for these versatile materials. Production cost reductions of up to 90 per cent and production time cuts of over 60 per cent have been realized by the use of flexible plastisol molds in the casting of prototype models of appliance parts.

This process, developed by the Appearance Design

Section of General Electric Company's Small Appliance Division, economically and efficiently produces uniform models of electric iron handles, fan motor casings, and electric clock cases for consumer and marketing surveys. Flexible plastisol molds produce prototypes at about one-tenth the cost of temporary metal molds; they resist breakage better and cast more models than plaster molds; and they eliminate the costly, time-consuming finishing of metal parts produced in standard sand molds.

While the simplest plaster mold takes up to four hours to make, the same mold prepared from a vinyl resin-based plastisol usually requires only one and one-half hours. More intricate plaster molds may take up to sixteen hours to make and require four to five different mold pieces. An identical plastisol mold, completed in five hours, can be made in one piece because of the flexibility imparted by the vinyl resin.

Abrasion-resistant plastisol molds have produced up to twenty castings as compared with four from a plaster mold. Each part cast after the first in a plaster mold required up to three hours finishing time, while castings from a flexible mold require no finishing and are uniform throughout the entire run.

The molds are prepared by making a wooden or plaster pattern of the desired part. Free-flowing plastisol is poured around this pattern, faithfully filling out intricate detail, and then fused to a solid form. After fusing, the flexible mold is stripped from the pattern, leaving an exact mold cavity into which a low temperature curing compound, such as an epoxy resin, is poured.

Foamed Plastisols

Another relatively new method of processing vinyl dispersions is by the foaming of plastisols. These foamed vinyl dispersions may be classified into two groups according to their type of cellular structure. The first group has a structure consisting primarily of connected cells and will pick up water in the same manner as a sponge. The cellular structure of the second group is composed essentially of unconnected cells. These materials do not act like a sponge and are often used for flotation applications.

When relatively free expansion is permitted during fusion, a connected cell type of foam will result. Unconnected cellular material is fused under pressure of approximately 2000 pounds per square inch, with expansion occurring by means of further heat-processing after the product is removed from the mold.

At the present time there are two methods of producing multicellular, or connected cell, vinyl foam. The first of these is by absorbing a gas, such as nitrogen or carbon dioxide, into the plastisol while under pressure. Elastomer Chemical Corporation has developed a patented *(U. S. Pat. 2,666,036)* foaming process based on this method.

The second method used is the chemical expanding of the vinyl compound by blowing agents such as sodium bicarbonate, ammonium carbonate, or commercial nitrogen foaming agents. With the application of heat, these powders are converted into gases, which, in turn, sponge or foam the plastisol.

Unicellular foam vinyl is also prepared by chemical blowing of the plastisol. A commercial foaming agent is usually incorporated into the plastisol by milling or grinding. Either steel molds, capable of withstanding internal pressure of 2000 pounds per square inch, or thin sheet metal molds, which are subsequently placed in a heavy container constructed to withstand these pressures, can be used.

When properly formulated, the chemical, moisture, salt water, grease, and oil resistance of vinyl resins are imparted to foamed plastisol products. The flame-resistant qualities, the superior aging properties, and the wider temperature range of usefulness of foamed plastisols has led to an ever-increasing number of applications for these materials.

Potting Compound

Vinyl dispersion resins can be used to formulate plastisols with excellent electrical properties. For this type of application, it is quite important that the components used in the formulation be so-called "electrical grade" materials with a minimum of impurities. Vinyl chloride resins are to be preferred.

The first application for vinyl resin-based plastisols was the filling of voids in electrical cable. Since that time, many new uses for these materials in the electrical field have presented themselves.

A good example of the scope of vinyl plastisol electrical applications is their use as "potting" compounds for panelboard busbars. This application uses a cavity mold to obtain the proper build-up and correct positioning of the insulating material within very close tolerances. Ordinary insulating materials, forced around the delicate copper conductors, tended to damage or derange these inserts. After assembly of the cavity mold, however, a fluid plastisol may be flowed into place under low pressure without affecting the position or shape of the conductors. Baking of the busbar at temperatures ranging between 325° and 350° F. resulted in a firm, resilient insulation.

The vinyl dispersion insulation reportedly keeps the conductors noticeably cooler than does air. The fluidity of vinyl resin-based plastisols and the relatively low fusing temperatures, coupled with their long service life and resistance to water, chemicals, greases, and oils, assure an important place for these materials in the electrical field.

Slush Molding

Vinyl resin-based plastisols are well suited for still another unusual type of application. Slush molding of many articles, in large or small quantities, and with minimum mold cost and maximum production flexibility, can be carried out through the use of these vinyl resin dispersions. Boots, rubbers, gas masks, flexible bottles, fishing lures, and falsies, have all been molded by this method.

The cost of molds and time of mold production have always been two drawbacks in compression and transfer molding. Slush molding, however, utilizes working molds that are quickly and economically produced by electrodeposition of copper. The time required to produce these molds ranges from three to seven days, depending on the mold size, the wall thickness desired, and the plating process. Molds prepared by this method appear to have an indefinite life, and, since there is no parting line, finishing of the molded product is not necessary.

In the production of a slush mold, a finished model of the desired article is used to produce a sectional plaster of paris mold. The plaster mold is used to cast wax pattern, which is then smoothed, polished, carefully cleaned, surface sensitized, and suspended in an agitated plating solution.

The time required for copperplating of the wax pattern is dependent upon the size of the mold, the thickness desired, and the plating process. A compromise must be reached between the production time and the quality of the mold. Molds having a fine, dense copper structure are obtained when the plating current amperage is low. The attainment of these mold properties, however, requires

a longer build-up time. If the amperage of the plating current is too high, the mold will have a large crystalline structure and there is a tendency toward a burned mold surface. Each day during the build-up of the copper mold, the part is removed from the plating bath, water-washed, and replaced in a different position to ensure uniform plating. After the necessary thickness has been obtained, the mold is removed, the wax melted out, and the interior of the mold cleaned.

Basically, the slush molding process entails filling the mold with plastisol, dumping the excess material, curing the film which remains on the mold walls, cooling the mold, and stripping the finished product from the mold.

The mold is filled from a reservoir of plastisol and, if necessary, entrapped air is removed. At this point the excess plastisol can be drained into a recovery tank or the mold can be heated before draining to increase the wall thickness. Preheating of the mold will also give a thicker coating on the interior.

In either case, after draining the excess plastisol from the mold, the mold is heated to gel the plastisol remaining on the mold walls. This heating operation can either completely cure the plastisol if the desired thickness has already been obtained, or simply partially fuse the material preparatory to the application of a second coat. When the latter is necessary, the mold is refilled with the plastisol, drained, and heated to the fusing temperature. After final curing, the mold is cooled and the molded article is removed. The speed and flexibility of this process is illustrated by the fact that one company reportedly turns out some 6000 pieces every 8 hours, using 200 molds costing on the average only $10 apiece.

As in all pastisol applications, the type and quality of the components used in the formulation determine the successful application of the dispersion. The repeated draining of warm plastisol into the recovery tank requires a compound with exceptional viscosity stability and aging characteristics. Therefore, the resin, plasticizer, and stabilizers used must be selected with this in mind.

Reverse Slush Molding

Another method, used for producing overshoes, might be referred to as reverse slush molding. This application technique, using the same type of economical mold, consists of dip-coating the outer sides of the mold with a vinyl resin-based plastisol. After over-curing at approximately 350° F., the finished overshoe is stripped from the mold and turned inside out. This operation results in an outer surface that faithfully reproduces a negative of the design on the outside of the mold. Extra thicknesses on the soles can be obtained by a second dipping after the first coating has air-dried for a few minutes.

These products are resistant to scuffing, abrasion, and temperature changes. They retain their flexibility and elasticity, and their colors do not fade. Here again, the plasticizer must be selected with care; the water extractability and low temperature characteristics being of prime importance.

Another dip-coating application involves a tough new safety covering for air-spray bottles to prevent sharp fragments from scattering if the bottle is dropped. Attractively colored, translucent and warm to the touch, this soft plastisol coating provides necessary impact elasticity and tear strengths.

Bottling perfumes and other liquids under pressure in order to force them out in a fine mist also increases the danger from flying splinters when an uncoated bottle shatters. Dropped 25 feet onto concrete, the plastisol-covered bottle breaks, but fragments do not pierce the coating and scatter, according to the manufacturers. This new safety coating clings to the shape of the bottle and can be made clear and translucent or opaque in a full range of colors. Because of the chemical resistance of vinyl dispersion resins, the coating is not affected by the essential oils and alcohols contained in perfumes and cosmetics.

Developed by Wheaton Plastics Company, these plastisol-covered bottles are available in three stock designs and can be molded to special designs in sizes up to six ounces. Product identification or a sales message may be printed in any color either on the vinyl coating or on the bottle itself.

Up to this point the discussion has been centered on plastisol applications. For the most part, this has been because plastisol applications, by the very nature of the material, tend to be unique in their conception and realization. However, in conclusion, several typical organosol applications should be mentioned.

Metal Decorative Field

In the metal decorative field, organosol coatings are recognized for their excellent abrasion resistance and general durability. Organosol baking coatings offer the ultimate in toughness, inertness, and chemical resistance for vinyl coating materials. These coatings are applied by spraying and are fused at approximately 350° F. to obtain a smooth, continuous, homogeneous film. Normally these coatings bake to a satin finish, but very recently an organosol finish has been developed which gives a glossy finish upon baking.

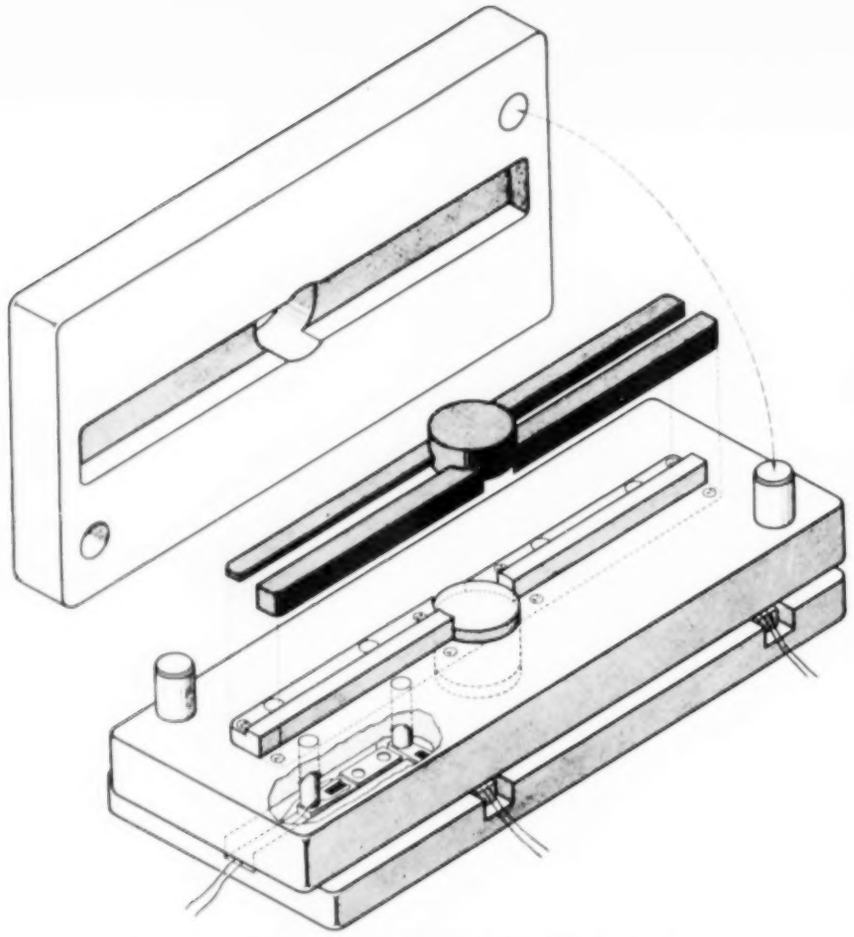
Organosol coatings are being used to protect the metal parts of office chairs from abrasion, oils, and greases. The exceptional durability of these dispersion coatings also recommends them for other office equipment such as file cabinets, typewriter tables, time clocks, business machines, and similar items. Metal lawn furniture, washing machines, refrigerators and other consumer goods also show great promise for future applications of vinyl resin organosols.

Wrinkle-Finish

A new wrinkle-finish coating with a rich leather grain texture is based on vinyl resins for endurance under the hardest wear and for strong adherence to metal surfaces. Wear tests show that this coating, known as "Armorhide," has 10 times the abrasion resistance of conventional baked-on wrinkle finishes, according to the manufacturer. The economical spray-on method of applying this textured coating was developed by John L. Armitage and Company, using vinyl resins supplied by Bakelite Company.

The first commercial use of the new textured coating provides distinctive new styling and a tough finish for the upper instrument panel of the 1955 DeSoto automobiles. Back panels of fold-down rear seats in 1955 Plymouth and Dodge station wagons also use the long-lasting textured finish to withstand heavy wear. Oil smudges, grease, dust, dirt and water wipe off without leaving a trace due to the excellent chemical resistance of vinyl resins on which the tough coating is based.

As illustrated by the preceding examples, dispersion coatings are finding wider acceptance in many industrial applications. The potentials opened in the industrial field by the excellent performance characteristics of vinyl resin-based dispersions pose a challenge to the ingenuity and foresight of chemical, manufacturing, and maintenance development engineers.



Internal Pressure Distribution In Molding

. . . . phenolic test bars

J. M. Rausch and W. Orvis
Bell Telephone Laboratories

Figure 1. Sketch of Mold Showing Strain Gauge Mounting.

Introduction

PRESSURE IS ONE of the fundamental variables in the processing of either thermoplastic or thermosetting materials. In fact, it is included as a basic part of the definition of the term "plastics" (D883-52T) adopted by ASTM Committee D-20 which states "a plastic—at some stage in its manufacture has been or can be formed (cast, calendered, extruded, molded, etc.) into various shapes by flow—usually through the application singly or together of heat and pressure." Of necessity, numerous studies have been made of the pressure limits essential for satisfactory molding, but the literature reveals a scarcity of information concerning the degree to which pressure is transmitted and distributed by the plastic in the mold during the molding process. Few data are available on how possible non-uniformities in the internal pressure distribution might affect the strength of a molded article. This is particularly true in the case of thermosetting materials which have found wide application in the telephone industry, notably in the telephone handset. In view of the lack of such data, this investigation was undertaken with the object of studying the pressure distribution in a relatively simple test bar mold using a phenol formaldehyde thermosetting material. It was the initial phase of a program planned ultimately to determine if any relationship might be established between the pressure distribution and Izod impact strengths at various corresponding positions along the molded bars. A search for more basic knowledge of the molding process, particularly the part played by pressure, was prompted in turn by the ultimate desire to be able to predict the impact properties of telephone handles on the basis of Izod impact test data with the elimination or control of as many variables as possible.

Pressure measurements in plastics processing equipment have been made by several workers. Prominent in this field have been G. D. Gilmore and R. S. Spencer, who have conducted extensive investigations into the interdependent roles played by pressure, temperature, and time in thermoplastic injection molding. In some of their early work (1), they measured internal pressures in a box mold using an arrangement whereby the pressure was transmitted through a plunger in the mold to an externally mounted pressure head. The pressure head employed strain gages to convert the force into an electrical signal which in turn was amplified, rectified, and indicated on a D.C. milliammeter or recorded on a Speedomax recorder. Later these same authors expanded their study by the construction of a glass-faced die which enabled them to supplement their quantitative measurements with visual and photographic observations of the flow pattern inside the mold (2, 3).

Their results with polystyrene led them to the conclusion that the mechanically controlled injection machine cycle is only one of many variables that determine the polymer cycle or the sequence of events which occur within the machine. The polymer cycle they found could be broken down in the order: dead time, mold filling, mold packing, discharge of polymer from the mold, sealing of the gate, and sealed cooling. Maximum pressure was obtained during the packing phase of the cycle but it

was usually substantially lower than the applied ram pressure, the exact transmission efficiency depending upon the various molding variables in each case.

Several additional papers concerned with phases of plastics processing other than molding are of interest chiefly because of the pressure measuring techniques employed. J. T. Bergen and G. W. Scott (4) have reported a study of the pressure distribution in the calendering of plastic material. Their experimental method involved the use of a high speed oscillograph connected to strain gages in a pressure sensitive cell which was mounted under a steel diaphragm on the surface of the calender roll. Pressures transmitted through the steel diaphragm to the oscillograph were photographically recorded. W. T. Pigott (5) investigated the design and operation of screw extrusion machines insofar as these factors affected the pressure and discharge rates of Newtonian liquids and rubber-like materials. Ordinary hydraulic gages were adapted to the extruder for pressure measurement. J. F. Carley (6) described a bourdon type gage modified for measuring pressure in polymer processing equipment such as dies, extruders, and injection molding machines. He felt this to be superior in some respects to the earlier strain gage apparatus used by other workers.

None of the work briefly discussed in the foregoing paragraphs has mentioned pressure transmission or distribution in molding thermosetting materials, although large scale commercial use of these materials preceded the development of most thermoplastics. Consequently, the present investigation of pressure and impact strength for a phenolic molding material was felt to be not only of specific application to the molding of telephone handsets but of general interest as well.

Experimental

This study of pressure distribution constituted but one phase of a program which had as its ultimate goal the establishment of a correlation between the Izod impact strength of test bars and the impact properties of a telephone handle. In designing a test bar mold to produce Izod test specimens, the main requirement was that the flow pattern should be as nearly like that occurring in the telephone handle mold as practicable. Telephone handsets are molded of a thermosetting phenolic material in a compression mold using electronically preheated preforms. The preforms are placed in both the receiver and transmitter ends of the cavity with the result that as the press closes, the material is forced to flow a considerable distance to fill the handle. Such a high degree of flow does not occur in the standard compression molded Izod test bar. At the same time, neither does the flow take place through a small gate as in the customary transfer mold. As a result a compromise design, a transfer mold with a large adjustable gate, was devised as the one which would most nearly reproduce the flow pattern existing in the handle mold. Figure 1, a sketch of the mold, shows the centrally located gates and the four 5" cavities, two with ½" x ½" cross sections and one each with cross sections ½" x ¼" and ½" x ⅛". Figure 2 shows the molded piece with the designation given to each half bar.

Pressure measurements were made at six points in the die, two in one of the ½" bars and two each in the ¼" and ⅛" bars, at locations 1" from the far end and 1⅝" from the gate end, respectively. In subsequent work, each bar would be cut into two specimens for Izod impact tests, and these points were so situated as to measure pressures adjacent to where the notch would be made in each specimen. At each point, a 0.380" diameter vertical hole was machined through the lower face of the die to a space below. In the hole, its upper surface flush with the cavity face, floated a closely fitted hardened cylindrical steel pin, the lower rounded end of which rested on the unsupported end of a cantilever beam rigidly fastened to the lower mold base. The beams were made of beryllium copper and were so designed that maximum deflection was obtained at pressures of about 3000 psi in the interior of the die. An SR-4 strain gage cemented on the upper horizontal face of each beam then afforded an extremely sensitive arrangement for magnifying and measuring the deflection caused by even slight pressures on the pin in the mold cavity. Figure 1 shows a detail of one of the strain gage mountings.

Wires from the six strain gages were run to terminal blocks (not shown in Fig. 1) on the outside of the die base. From the terminal blocks, wires provided with alligator clips made whatever connections were desired to an SR-4 strain recorder. The recorder, equipped with a 1 r.p.m. clock, made possible the simple automatic recording of the molding cycle in terms of pressure for any one of the six locations, but for only one during a single run.

Experimental Procedure

A prerequisite to any pressure measurements after the test bar die had been assembled and wired was the calibration of each strain gage paired with its compensating gage. The compensating gage was obtained by simply removing one of the steel pins and inserting a brass plug in the hole so that no pressure could be exerted on the cantilever beam below. This had the advantage of furnishing a compensating gage undergoing the same treatment as the active gage, but it was important to use consistently the same pairs of gages throughout both the calibrations and the actual measurements. The calibrations, made with the die at the molding temperature of 320°F., were carried out by removing the upper die-plate to expose the pressure pins. Vertical force was then applied to a pin via a 2000 lb. Morehouse proving ring calibrated by the Bureau of Standards, the ring placed between the pin and the upper platen of a 30 ton hydraulic press. Increasing the pressure from zero to the desired maximum in approximately even increments, and taking simultaneous readings of the ring and the deflection on the SR-4 Strain Recorder gave a calibration curve for the pin expressed as psi per unit of deflection.

In obtaining the experimental data, the test bar die was placed in a 60 ton hydraulic press equipped with a suitable transfer ram. The die was brought to 320°F, the selected molding temperature, and the clamp and transfer pressures set at 30 tons total and 1.5 tons in.$^{-2}$, respectively. The active and compensating gages were connected

Figure 2. Molded Test Bars with Pressure Point Designations.

TEST RESULTS

Figure 3

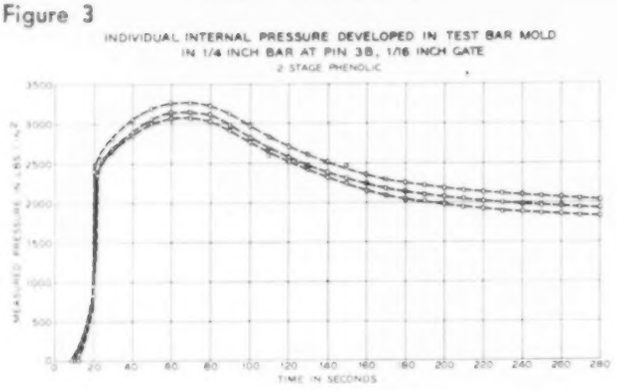

INDIVIDUAL INTERNAL PRESSURE DEVELOPED IN TEST BAR MOLD
IN 1/4 INCH BAR AT PIN 3B, 1/16 INCH GATE
2 STAGE PHENOLIC
MEASURED PRESSURE IN LBS./IN.²
TIME IN SECONDS

Figure 4

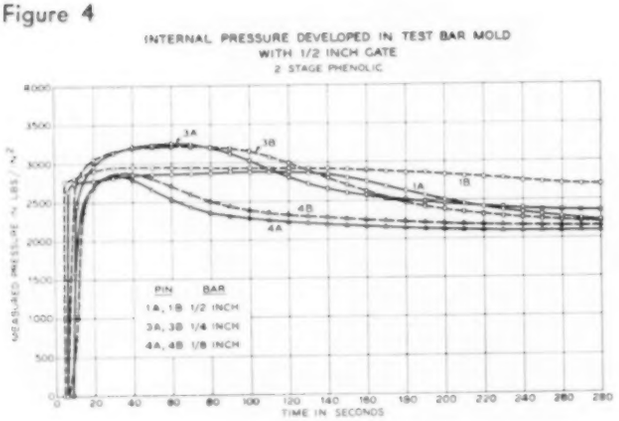


Figure 5

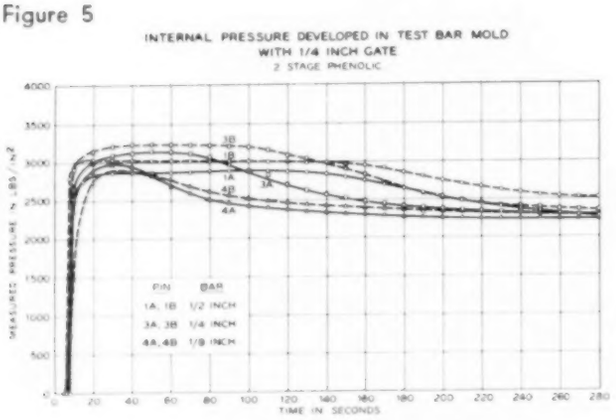
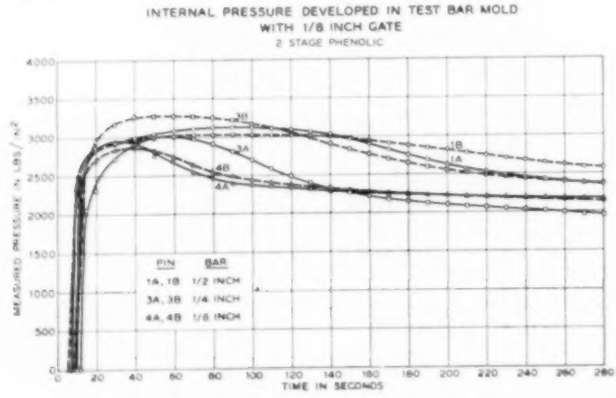


Figure 6



to the SR-4 Recorder. Two 50 gm., 1.5″ diameter preforms of the phenolic material being tested were electronically preheated to 220°F and quickly placed in the transfer chamber above the die. At the instant the transfer ram was started downward, the clock in the SR-4 recorder was switched on causing the circular chart to revolve at 1 rpm. This technique provided the same initial starting point for every measurement. From this point the run was automatic, the pressure cycle being recorded on the chart until the press opened after a preselected cure time. After each run, removal of the die from the press, disassembly to clean the pins of any residual flash, and reassembly was necessary. The design of the die and pressure measuring system did not make this operation too difficult or time-consuming.

Experimental Results

Figures 4 through 8 show the pressure cycles obtained on a commercial, two-stage, general purpose, phenolic molding material employed in telephone handset manufacture, a medium flow material containing 47% wood flour and approximately 3% cotton flock. Curves are given for the two locations in each of the ½″ x ½″, ¼″ x ½″, and ⅛″ x ½″ bars for a range of gate sizes, point B near the gate and point A at the far end of each bar as illustrated in Figure 2. These curves are averages from a number of runs (3 to 8) among which there was some degree of variation which could not be eliminated completely in spite of the best possible control of experimental conditions.

Typical of the average spread encountered in repetitive runs are the pressure curves in Figure 3 obtained on the ¼″ bar at location 3B with a 1/16″ x ½″ gate. In some instances, the agreement was considerably better than this. The poorest reproducibility was encountered in making measurements on the ½″ bar at the point nearest the gate (1B) with a 1/32″ x ½″ gate. As the gate became smaller, the measured pressures became increasingly sensitive to experimental conditions, and the larger the volume of the bar to be filled, the more sensitive they became. However, a sufficient number of runs and checks were made in every case to establish a satisfactory average pressure cycle.

The bars were gated at one end, the width of the bar, ½″ being the width of the gate, with the height of the gate adjustable to ½″, ¼″, ⅛″, 1/16″, and 1/32″. Hereafter, in this discussion, gate size will be designated by height only. Naturally, a gate equal to the cross-section of a bar is the largest possible gate for that particular bar. However, on Figure 4 will be noted a curve for a ¼″ bar with a ½″ gate. Since the bars were not gated individually, this refers to the maximum gate used for the set of four and strictly applied only to the ½″ bar. Curves secured with a ½″ gate should thus be identical to those with a ¼″ gate for the ¼″ bar. Similarly, measurements with ½″ and ¼″ gates should check those for the ⅛″ maximum gate in the ⅛″ bar. Within experimental limitations such agreement was obtained.

Consideration of Figures 4-8 brings out several interesting points. Perhaps the most immediately striking of these is that in some cases the measured internal pressure exceeded the applied transfer pressure giving an indicated pressure transmission efficiency of 100% or over. Only when the gate size was reduced to 1/16″ did the indicated transmission efficiency fall appreciably below 100% at any of the six points. Even with a 1/32″ gate the transmission was roughly 93% in the ½″ bar and at the worst about 50% in the far end of the ⅛″ bar.

TEST RESULTS

The maximum internal pressure for the two-stage material under the test conditions occurred in the ¼" bar where 3250 psi was measured at point 3B against an applied ram pressure of 3000 psi for gate sizes of ¼" and ⅛". There was an indication in this bar of a trend toward lower pressure at point 3A most distant from the gate. This was especially true with the ⅛" gate in which case the measured value of 3000 psi at point 3A compared with the 3250 psi measured at 3B nearest the gate. Decreasing the gate to 1/16" increased this non-uniformity, giving 3150 psi at 3B and 2425 psi at 3A, while a decrease to 1/32" reduced the pressures appreciably at both locations to 2550 psi and 2090 psi, respectively. In the ⅛" bar, measured pressures of about 2900 psi were close to the applied pressure (3000 psi) at both points 4A and 4B until the gate was reduced to 1/16" when point 4B nearest the gate read 2550 psi and point 4A at the far end 2050 psi. With a gate of 1/32" the corresponding values were 1800 psi and 1500 psi, the lowest measured pressure. Pressures in the ½" bar held at 2900-3000 psi at both locations 1A and 1B until a reduction in gate size to 1/32" cut them to 2800 psi, again the same at both points. This uniformity of pressure distribution in the ½" bar was of particular significance since these are the bars upon which Izod data will be obtained and a correlation attempted in the next phase of this program.

The pressure cycle curves nicely illustrate the comparative rates of cure of the bars, the thinner bar naturally curing more rapidly since the material in it reached die temperature more quickly. Pressures in the ⅛" bars reached their maximum values in about 30 sec. after which curing almost immediately resulted in shrinkage and drop in pressure. The ¼" and ½" bars reached maximum pressures in approximately 60 and 100 seconds, respectively, followed by shrinkage and pressure drop as curing proceeded.

All of the foregoing work was based on the general purpose two-stage phenolic molding material used in telephone handset manufacture. To date, only a very brief study has been made on the molding cycle of one other material, a commercial, single-stage, general purpose phenolic. The results, shown in Figure 9 for a ¼" gate, were extremely interesting in that the measured internal pressures were much higher than for the two-stage material. At point 1A, most distant from the gate in the ½" bar, the measured pressure exceeded the applied transfer pressure of 3000 psi by 1250 psi. This high pressure was maintained with very little decrease even after 10 min. cure, which would indicate practically no shrinkage occurring in the mold. Furthermore, in contrast to the uniform pressure distribution exhibited by the two-stage material with a gate of this size (¼"), the single-stage phenolic not only exhibited non-uniformity but lower pressures near the gate than at the far end of the bar, a reversal of expectations. This was true in both the ½" and ¼" bars, the only ones for which pressure data were obtained.

Sufficient Izod impact data have not yet been obtained to complete a correlation with the internal pressure measurements. This is now being done. However, some evidence of a difference between the A and B sections of the bars has already been observed in the physical nature of the fractures which have resulted in ½" bars tested according to ASTM specification D256-47T. Photographs of typical fractures of these bars molded with a ¼" gate are shown in Figure 10. Whereas the A half of the bar exhibited a fracture perpendicular to the notched face, the B half broke at an angle of 35°-50°. This difference disappeared, the fractures becoming more uniform when

Figure 7

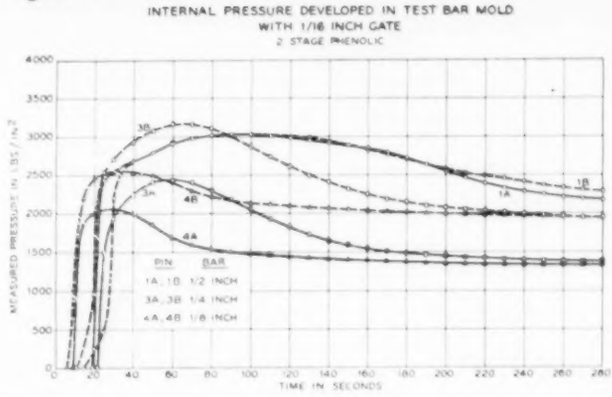


Figure 8

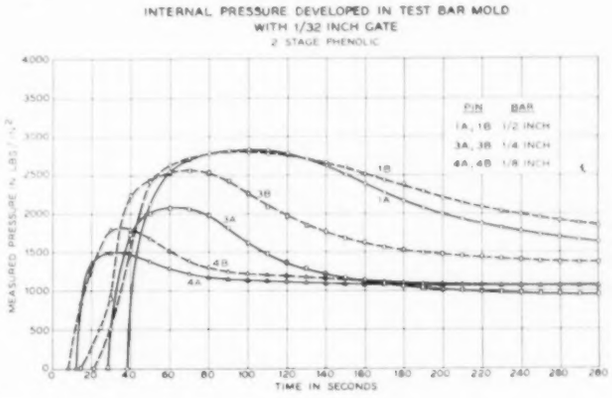


Figure 9

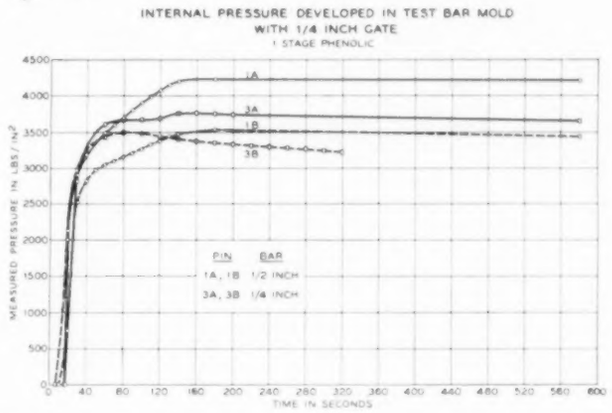


Figure 10

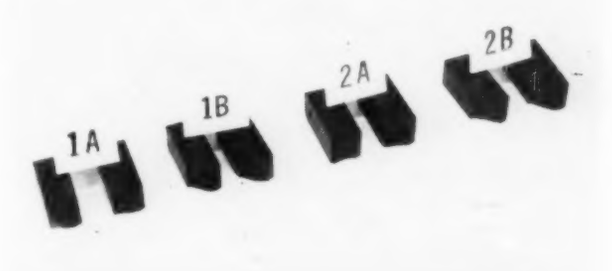


Figure 10. Notched Izod Fractures Obtained on A and B sections of ½" test bars.

the gate was reduced to 1/32", indicating that gate size, perhaps as it influences the plastic flow pattern, may be an important factor in future considerations of the relationship between internal pressure and impact strength.

Discussion of Results

The fact that the measured internal pressures in the test bar mold exceeded the applied pressures under certain conditions, is an indication that factors in addition to those normally involved in fluid flow are operative in determining the polymer pressure cycle. Undoubtedly, friction is important in these phenolic molding materials for there must be some friction in the passage through the gate and along the cavity, friction which tends to reduce the internal pressure. Were this the only element to consider, the pressure drop would be inversely proportional to the cross-section of the bar and directly proportional to the distance from the gate. Thus, the pressure in the ⅛" bar would be less than in the ¼" bar where it in turn would be less than in the ½" bar, a fairly simple relationship giving transmission efficiencies of somewhat less than 100%. However, the frictional pressure drop must be counterbalanced to various degrees by thermal expansion caused by the temperature differential between the preform at 220°F. and the die at 320°F., and also by entrapped water vapor or other volatiles either present in the material initially or liberated in the reaction. Conceivably, these might combine to cause the internal pressure to exceed the applied transfer pressure in certain instances. Still further complications may be introduced by more rapid attainment of temperature equilibrium in the thinner bar, which signifies more rapid cure. The material entering the ⅛" bar is probably at a higher temperature when the bar is filled than it is in the larger bar. This results in less pressure caused by thermal expansion, but it also means more rapid cure and freezing of the gate. With the gate frozen any internal pressure in excess of that applied cannot be relieved by reversal through the gate. It must be locked in the bar and exerted on the strain gages. The measured pressure cycle then is the result of the simultaneous interaction of six factors, applied pressure, frictional pressure drop, thermal expansion, entrapped volatiles, rate of attainment of temperature equilibrium, and cure rate. In the case of the two-stage resin, these combined to cause maximum pressure to occur in the ¼" bar, and evidently the factors tending to increase the pressure were of sufficient magnitude to produce an internal pressure exceeding the applied transfer pressure by 250 psi. In the one-stage resin, the formation of water during the curing reaction, and its entrapment in the material as vapor, may have accounted in large measure for the high internal pressure of 4250 psi as compared to the applied pressure of 3000 psi.

The effect which gate size was observed to exert on the nature of the fracture of the ½" test bars (Figure 10) suggested that the fracture might be related to the pattern of plastic flow which occurs in the mold. One explanation for this difference between the A and B sections of the bars molded with a ¼" gate and the disappearance of the difference with a smaller gate, might lie in the tendency of the smaller gate to "freeze" more rapidly. This would prevent movement of material either into or out of the cavity during the later stages of curing, movement which in the case of the larger gate could disrupt the polymer network resulting in discontinuities or in shorter, weaker chains. This disruption which would be a maximum at the gate, decreasing along the bar, could very well result in a different type of fracture near the gate when the gate was sufficiently large. Further confirmation of this theory may be forthcoming when the Izod impact data are completed.

In addition to the more specific points of interest discussed in the foregoing paragraphs, several items of general interest emerged from the pressure measurement phase of this work. Following the sequence described by Gilmore and Spencer for polystyrene, the molding cycle for the phenol-formaldehyde materials may be broken down into (1) dead time, (2) mold filling, (3) reversal or discharge of polymer from the cavity, (4) gate sealing, and (5) curing in the hot die. Maximum internal pressures occur during the mold filling or discharge periods of the cycle.

As Gilmore and Spencer also found for polystyrene, the external mechanical molding cycle does not completely determine the polymer cycle, at least for the one and two stage phenol-formaldehyde materials used in this investigation. The behavior of the single stage phenolic was glaring evidence of this point. Internal pressures of 4250 psi were measured although the applied pressure was only 3000 psi, and these pressures were maintained throughout the curing period, indicating very little shrinkage in the mold. Herein lies a possible explanation for an earlier unsuccessful attempt to mold telephone handsets of this material. The handle cavity was filled satisfactorily, but after curing, the handles proved so difficult to remove from the cavity that some were cracked in the process. Sticking caused by high internal pressures and a very small amount of shrinkage in the mold could very well have been responsible for the difficulty. In certain circumstances such as this it is possible that in spite of all the external variables which the molder has at his command he may not be able to exercise sufficient control over some inherent polymer variables to enable him to produce a particular part from a given material.

Conclusions

The strain-gage pressure measuring technique has been satisfactorily applied to the measurement of the internal pressures developed in a "semi-transfer" test bar mold by both one and two-stage general-purpose phenolic molding materials. The results have shown that under certain circumstances the internal pressures can exceed the applied pressures, making possible apparent pressure transmission efficiencies in excess of 100%. Pressure distributions for the two-stage material were quite uniform throughout all of the test bars with gate sizes of ⅛" x ½" and above. In the ½" x ½" bars, pressures were uniform along the bar for all gate sizes from ½" x ½" to 1/32" x ½", a result of potential importance in the next phase of this work, attempting to relate the internal pressure distributions and the Izod impact strengths of these bars.

The polymer cycle was found to be determined only in part by the mechanically controlled molding cycle. Excessive internal pressures and very low shrinkages beyond the control of the molder could make the use of a given material in a particular mold extremely difficult or even impossible.

A great deal of additional work could be carried out on thermosetting-molding materials, using the test bar mold and pressure measuring equipment. Only a narrow range of molding conditions has been investigated thus far. An extension to broaden the range of temperatures, pressures, etc., might yield results of value in establishing optimum molding conditions for optimum physical properties.

(Please turn to page 58)

HELLO, V.I.P.'s!

The 12th Annual Technical Conference (January 18, 19, and 20 in Cleveland, Ohio) is open to both members and non-member guests. We welcome the guests and ask you to consider becoming one of us.

Stop by the Membership Desk

We urge non-member guests to visit us at our headquarters, near the General Registration Desk. There we will give you full information on all phases of S.P.E. membership, including the location of the section nearest you and the names of its officers.

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The Twelfth Technical Conference

Society of Plastics Engineers

Registration

MEZZANINE

Tuesday	1:00 p.m. to 9:00 p.m.
Wednesday	9:00 a.m. to 5:00 p.m.
Thursday	9:00 a.m. to 5:00 p.m.
Friday	9:00 a.m. to 12:00 noon

MOVIE FILMS OF THE INDUSTRY

Wednesday and Thursday
9:00 a.m. to 12:00 noon
Club 345

Tuesday, January 17, 1956
Informal Smoker — Ohio Room
8:00 p.m.

WEDNESDAY, Jan. 18

Invocation and Official Opening of Conference
Euclid Ball Room — 9:00 a.m.

SESSION I — EUCLID BALL ROOM
9:30 a.m. to 12:00 noon

INJECTION MOLDING

Moderator — Gordon Thayer, Dow Chemical Co.

A New Measure of Plastic Moldability —D. B. Someyn, Dow Chemical

Heating Cylinder Design—R. B. McKee and Mario Maccaferri, Mastrow Plastics Corp.

Inside the Injection Mold with Polyethylene—C. E. Beyer, R. W. Miler, M. Q. Tessin, Dow Chemical

Automatic Molding — D. H. Lewis, Packard Electric

Standardization of Injection Molding Equipment — A. J. DeMatteo, Watson-Stillman

SESSION II — PINE ROOM
9:30 a.m. to 12:00 noon

EPOXY RESIN SYMPOSIUM

Moderator—F. S. Swackhamer, Shell Chemical

Development of an Epoxy Resin Potting Compound, etc.—W. H. Crandell, F. S. Bacon Labs.

Electrical Applications for Epoxy Resins—Dr. H. Rudoff, A. J. Rzeszotarski, General Electric

Reinforced Epoxy Pipe — D. Boggs, Fibercast Corp.

Epoxy-Base Adhesives in the Aircraft Industry—W. Bandaruk, Convair

Epoxy Resins in Plastic Tooling—L. R. Sparrow, Republic Aviation

SESSION III — OHIO ROOM
9:30 a.m. to 12:00 noon

PROPERTIES OF PLASTICS

Moderator—Louis F. Rahm, Princeton University

Effect of Explosions on Plastics—H. A. Perry, Jr., U. S. Naval Ordnance

Determination of Fracture Temperature of Imbedment Castings—L. S. Buchoff, Westinghouse Electric

Service Temperature Characteristics of Thermoplastics—J. J. Gousa, E. N. Robertson, Rohm & Haas

Irradiation of Plastics—D. S. Ballantine, Brookhaven - A.E.C.

The Utility of Impact Testing as a Criterion of Toughness—C. H. Adams, G. B. Jackson, R. A. McCarthy, Monsanto Chemical

WEDNESDAY AFTERNOON

MEMBERSHIP LUNCHEON AND BUSINESS MEETING 12:00 NOON

1:30 p.m. Closed Circuit Telecast
Manger Hotel Ballroom

SESSION I — EUCLID BALL ROOM
2:30 to 4:30 p.m.

MOLDING AND EXTRUSION

Moderator—J. H. DuBois, Mycalex Corp.

Compression and Transfer Molding of Guided Missile Parts—L. B. Keller, W. R. McGlone, Hughes Aircraft Co.

The Effect of Heat Treatment on the Polishability of Mold Steel—E. E. Lull, Crucible Steel Co.

Engineering of Purchased Molds — J. C. O'Brien, Shaw Insulator Co.

Cast-In Heaters—Wm. Norton, Thermel, Inc.

Stepless and Three Position Temperature Controls on Extrusion Equipment—R. K. West, West Instrument Co.

SESSION II — PINE ROOM
2:30 to 4:30 p.m.

THERMOPLASTIC SHEET

Moderator—A. J. Baldwin, Nixon Nitration Works

Plug Assist Forming: A New Sheet Fabrication Technique—J. W. Mighton, Dow Chemical

Large Area Stretch-Oriented Acrylic Sheet—A. Batzdorff, Rohm & Haas

Processing and Applications for Cellulose Acetate, High Impact Styrene and PE Sheeting — G. H. Henry, Celanese Corp.

Measuring the Effect of Plasticized Vinyls on Impact Polystyrene — R. R. Dixon, Westinghouse Electric

Characteristics of Biaxially Stretch Oriented Acrylics — D. A. Hurst, Rohm & Haas

SESSION III — OHIO ROOM
2:30 to 4:30 p.m.

RESEARCH SYMPOSIUM

Moderator—Bryce Maxwell, Princeton University

Flow Behavior of Plastics under Molding Conditions — D. I. Marshall, Bakelite Co.

Plasticity as a Tool in Resin Development — G. P. Rowland, Firestone Plastics

Physical Properties of Unmodified Rigid P.V.C.—F. W. Schneider, Firestone Plastics

Injection Molding Research — Today and Tomorrow — J. Eveland, H. J. Karan, C. E. Beyer, Dow Chemical

Tensile Impact — A Simple Meaningful Impact Test—C. G. Bragaw, Jr., E. I. duPont

INJECTION MOLDING

BULL SESSION — 4:45 p.m.
Parlors 1-2-3

COMPRESSION MOLDING

BULL SESSION — 4:45 p.m.

THURSDAY, Jan. 19

SESSION I — EUCLID BALL ROOM
9:00 a.m. to 12:00 noon

EXTRUSION

Moderator—Hans Buecken, National Rubber Machinery Company

Trends and Problems in European Extruder Design—E. Gaspar, Projectile & Engineering Co.

Viscosity Data for Extruder Flow Equations—Robt. D. Sackett, Monsanto

A New Development in Extraction-Extrusion: The Vacuum Extruder Screw—Ernest C. Bernhardt, E. I. duPont

Melt Fracture—Extrudate Roughness in Plastics Extrusion — J. P. Tordella, E. I. duPont

SESSION II — PINE ROOM
9:00 a.m. to 12:00 noon

CALENDERING AND COATING

Moderator—J. Leavy, E. I. duPont deNemours

Calendering Equipment—R. C. Seanor, Adamson United

The Calendering of Vinyl Sheeting—E. F. Wuest, Masland Duraleather Co.

Coating Equipment—Dale G. Higgins, John Waldron Corp.

Fabric Coating Techniques — E. G. Hamway, Textileather Co.

SESSION III — OHIO ROOM
9:00 a.m. to 12:00 noon

REINFORCEMENT OF PLASTICS

Moderator—Roger White, Glastic Corp.

Non-Glass Reinforcement of Plastics—Johan Bjorksten, Bjorksten Labs.

Reinforced High Impact Plastics — Paul Fina, Fiberite

Asbestos Reinforced Plastic Laminates — D. V. Rosato, Raybestos-Manhattan

Reinforced Plastics in the Construction of External Pressure Vessels—F. R. Barnet, C. L. Lloyd, U. S. Naval Ordnance

THURSDAY AFTERNOON

SESSION I — EUCLID BALL ROOM
2:00 to 5:00 p.m.

PLASTIC FOAMS

Moderator—E. J. Baruth, Brown Rubber Co.

Chemically Blown Foam—H. E. Arnold, E. I. duPont deNemours

Isocyanate Foams—Dr. C. J. Harrington, E. I. duPont deNemours

Vinyl Foam—H. F. Allen, Elastomer Corp.

Expanded Polystyrene — Fabrication Methods and Applications — G. K. Franson, Dow Chemical Corp.

SESSION II — PINE ROOM
2:00 to 5:00 p.m.

PLASTIC PIPE SYMPOSIUM

Moderator—George Anderson, National Tube

Cellulose Acetate Butyrate Pipe—R. J. Scogin, L. W. A. Meyer, Tennessee-Eastman Co.

Kralastic Pipe—Tough, Rigid, Chemically Resistant — P. M. Elliott, Naugatuck Chemical

Rigid Polyvinyl Chloride Pipe—J. F. Malone, B. F. Goodrich Chemical

Polyethylene Pipe—C. G. Bragaw, E. I. duPont deNemours

EXTRUSION

BULL SESSION — 4:15 p.m.
Parlors 1-2-3

SESSION III — OHIO ROOM
2:00 to 5:00 p.m.

REINFORCED PLASTICS

Moderator—Brandt Goldsworthy, Industrial Plastics Corporation

Present and Future Applications of Reinforced Plastics in Aircraft and Guided Missiles—Wm. E. Braham, Zenith Aircraft

Problems Encountered in Tooling World's Largest Airborne Reinforced Plastics Component — N. A. Nicholson, Zenith Aircraft

Tooling for Large Radomes — R. F. Vreeland, Hughes Aircraft Co.

Applications of Plastics in Marine Cathodic Protection Systems — M. Stander, H. Preiser, U. S. Navy: Bureau of Ships

Fire Retardant Electrical Grade Polyester Laminates—J. K. Allen, Westinghouse Electric

COCKTAIL PARTY AND PRESIDENT'S RECEPTION

OHIO AND PINE ROOMS
6:00 p.m.

BANQUET

7:00 p.m.
GRAND BALL ROOM
Banquet Speaker—Tennyson Guyer

FRIDAY, Jan. 20

SESSION I — GRAND BALL ROOM
9:00 a.m. to 12:00 noon

MATERIALS SYMPOSIUM

Moderator—Adolph Kisseleff

The Effects of Fabrication on the Properties of "Teflon" Tetrafluoroethylene Resin—P. E. Thomas, C. A. Sperati, J. F. Lontz, J. L. McPherson, E. I. duPont deNemours

Super Polyethylenes—Geo. H. Sollenberger, Koppers Co., Inc.

Silicone Product Development—Dr. L. E. Weisbecker, Bakelite Company

Cellulose Propionate Molding Compounds—D. Jones, Celanese Corp.

Polyethylene—Past and Future—G. N. Jargstorff, Geo. F. Kirkpatrick, Bakelite Co.

SESSION II — OHIO ROOM
9:00 a.m. to 12:00 noon

DESIGN SYMPOSIUM

Moderator—Otto Wulfert, Wagner Electric Co.

Designing with Transparent Plastics —A. N. Blumenfeld, Rohm & Haas Co.

Definitive Specifications for Plastic Materials of Construction — W. C. Wall, R. E. Brooks, E. I. duPont deNemours

Designing with Zytel Nylon Resin—A. J. Cheney, E. I. duPont deNemours

Analysis and Solution of Painting and Metallizing Problems — Lloyd E. Parks, Logo, Inc.

SESSION III — Parlors 1-2-3
9:00 a.m. to 12:00 noon

EDUCATIONAL COMMITTEE

Moderator—Jules Lindau, III

Training of Plastics Engineers

LADIES PROGRAM

PAGE 51

Plastics-Paper Combinations

E. C. Jahn and V. T. Stannett

State University of New York, College of Forestry, Syracuse, N.Y.

Introduction

The use of plastic materials in combination with paper has developed in a staggering fashion in the past few years. Although specific figures for the paper industry are not fully available the figures for urea-formaldehyde resins alone show the trend. The use of these resins in the United States paper industry alone totalled 22,000,000 pounds in 1953. In the case of plastics used in paper coating we note that polyethylene coated papers consumed 15,000,000 pounds in 1953 which accounted for 11% of the total consumption of this plastic material. Polyvinyl chloride compounds for paper coating in the same year totalled 19,000,000 pounds.

The rate of growth of the plastics industry itself reflects its dynamic character which is certainly carried over into the paper-plastics field. The production of plastics in the United States increased five-fold in the ten year period 1939-1949 reaching 1¼ billion pounds in 1949. Since 1949 the figure has doubled again reaching more than 2½ billion pounds in 1953. This figure does not include the synthetic rubbers which are also extensively used in combination in the paper and whose production totals a further 2 billion pounds.

The growth in the multiplicity of polymers commercially produced and in use is equally startling and within the past few years many new and outstanding resins have been successfully developed including the fluorinated polymers, polyesters, polyamides and the ethylene glycol terephthalic acid polymers known as Terylene, Mylar, or Dacron. In addition known resins are now being produced in new forms of great value to the paper and other industries, such as water emulsions or latices, plastisols and organosols and plastic-wax combinations making possible their applications as hot melts.

Keeping pace with the development of new resins are the engineering developments in machines and processes. Outstanding developments in fabricating and application techniques have been achieved in recent years thereby greatly extending the use possibilities of resin materials. These include electronic heating, vacuum forming, post forming of laminates, low pressure laminating and extrusion coating.

The nature of the plastics industry with respect to the many plastic materials produced and the diversity of process and application techniques is reflected in the combination of plastics with paper. The breadth and variety of plastic-paper combinations are very extensive. The many resin materials available permit the development of paper combinations with a great diversity of properties.

The first efforts to add resins or plastics to paper were to improve such properties as printability and gloss. Natural polymers were used such as resin, starch, casein and glues. With the advent of the synthetic resins efforts were made to improve further the properties of paper and this led to the development of entirely new properties and products from paper-plastic combinations. The growth and development of the plastics industry therefore directly supplements and extends the paper industry.

Methods of Application

A large number of techniques have been developed for applying plastics to paper and to a considerable extent the method used depends upon the nature of the plastic and the type of end product desired. Many plastics may be applied by several methods, however, and many end products can be obtained by more than one method of application. A general classification of methods of application may be listed as follows:

Tub sizing—the glazing or partial penetration of the paper sheet.

Saturation—the complete penetration of the paper.

Beater Addition—the addition of the plastic material to the pulp before its formation into a sheet or preform.

Coating—the application of a continuous layer of plastic to the paper by roll or knife coaters or by extrusion or casting coating devices.

Lamination—the calendering or other type of application of a plastic film or composition between two or more layers of paper or paper-cloth, paper-foil, or other combinations.

Types of Paper-Plastic Combinations

In this survey only a brief account is given of the types of paper-plastic combination produced stressing the more recent developments.

Sized Papers

The sizing of papers by various natural substances such as rosin, starch, and casein is an old art. These materials are related to plastics in that they are colloidal in nature. Rosin is still the most widely used sizing agent but more recently synthetic resin sizes have come into the picture and there is active research on new plastic sizes. Of these the rosin-maleic anhydride condensation product has been the most successful internal sizing agent. For surface sizing, materials such as polyvinyl alcohol and water soluble cellulose derivatives such

Guest lecture by Professor E. C. Jahn at Royal Technical University, Stockholm, Sweden, Feb. 24, 1954; publ. in Swedish in Svensk Papperstidning, 1954.

as carboxymethyl cellulose and methyl cellulose are used. Sizing is accomplished by tub sizing or beater addition methods.

Wet Strength Papers

Wet strength papers are already an accepted and important commodity. Maps, towelling, wrappers, bags and other items where wet strength is desired are manufactured in tremendous quantities. Thermosetting resins, mostly ureas and melamines, are mainly used. Cationic urea-formaldehyde resins are coming into extensive use and appear to show a definite improvement in wet strength over anionic or non-ionic types, even when the same retention of resin in the sheet is obtained. This point will be discussed further in an article on beater addition problems but is probably due to a more efficient use of the resin by a more economical distribution among the fibers. Wet strength resins are added in the form of aqueous solutions to the beater and are then precipitated by the addition of alum or other precipitant and settle out on to the fibers. More recently the use of neoprene (poiychloroprene) synthetic rubber in small amounts is being developed as a beater added wet strength resin.

Flexible Papers and Boards

Soft flexible papers and boards are produced by adding to the paper thermoplastic resins such as acrylic and vinyl polymers or elastomers such as styrene-butadiene and butadiene-acrylonitrile and neoprene synthetic rubbers. The plastic may be incorporated either by saturation techniques or by a beater addition process. The saturation procedure usually involves passing a soft absorbent grade of paper through a bath containing an emulsion of the plastic material. Many shoe parts (midsoles, insoles, sock lining) and artificial leather products are made by these techniques. Other uses include gasket papers, linoleum backings and semi-rigid products for packaging uses. For some purposes such as artificial leathers a coating of a plastic is applied to the resin treated sheet and subsequently embossed or polished by passage through appropriate rollers. Although saturation is still the most widely used method of adding the plastic to the paper, beater addition methods are under intensive investigation and are in use already in some plants. The chief advantage is to dispose of the additional operation of saturation and to produce the treated paper directly on the paper machine. Many techniques of beater addition have been developed and these will be discussed in another paper. It should be emphasized that these types of plastic-paper combinations contain up to equal parts of plastic and paper and the products in some ways resemble the plastic as much as the paper component.

Coated Papers

One of the most important applications of plastics to paper is in the field of coatings. Plastic coatings are applied to papers to develop functional properties and for decorative purposes. The most important functional properties are:

1. Gas and water vapor resistance
2. Water, liquid and grease resistance
3. Flexibility
4. Heat and pressure sealability
5. Chemical resistance
6. Protection of printing
7. Scuff resistance
8. Electrical insulation
9. Mold resistance
10. Structural strength
11. Avoidance of fiber contamination.

Important decorative properties imparted by the coatings are high gloss and color. Specialty coatings may require other features—playing cards for example must not only have high gloss and scuff resistance, but also have a pleasant "feel". Usually the coatings serve a number of functions. Very many different plastic materials are in current commercial use for paper coating either alone or mixed with wax, plasticizers, pigments, etc. The following are among the most important paper coating plastics available today: polyvinyl chloride, polyvinylidine chloride, polyvinyl acetate, ethyl cellulose, polyethylene, polyamides and nitrocellulose. The resins may be applied from a variety of mediums and many of them are available in several forms. Polyvinyl chloride resins may be applied from organosols, plastisols, solutions and emulsions; polyamides from hot melts or solutions and so on. The use of solutions is somewhat expensive owing to the cost of the solvents involved and the necessity for elaborate solvent removal and recovery system. In recent years the development of plastisols and organosols have helped overcome this problem. Plastisols are fine suspensions of polyvinyl chloride in liquid plasticizers such as dioctyl phthalate. These are applied to the paper and jelled to a continuous film by heat treatment. Organosols are plastisols containing some small proportion of a solvent and are of a lower viscosity than the corresponding plastisol and require a lower temperature for gelation. Consequently organosols have won most favor for paper coating. The fine suspensions are normally produced on paint making machinery such as ball mills, triple roller mills, and so on, but very recently resin manufacturers have produced grades of polyvinyl chloride which can be dispersed in plastiser-solvent mixtures by simple mixing techniques. Some stabilizer against deterioration is always added to polyvinyl chloride formulations, such as 0.5% of dibutyl tin maleate. New types of polyamide coatings which make excellent heat sealing coatings have been marketed. These are soluble in isopropyl alcohol and other solvents and may be applied from solution if desired; however, they are also excellent for hot melt application, either alone or mixed with a few percent of wax.

The most rapidly growing plastic in the paper coating field is undoubtedly polyethylene. This material has excellent heat sealing chemical resistance and flexibility characteristics and is outstanding for its low water vapor permeabilities. Owing to its high viscosity as a melt and lack of suitable solvents, polyethylene is applied by a new technique—the so-called extrusion coating process. Here the plastic is extruded as a film and on emerging from the die and, before cooling, it is caught in the nip of two rollers around one of which the paper is passing; the roll thus laminates the two together. The rolls are rotating at a greater speed than the extrusion rate and a considerable "draw down" of the plastic film takes place. This extrusion coating or extrusion lamination process has also been used very recently to produce nylon coated papers, but as far as is known no commercial use of these has so far been made. It should be emphasized that wax coated papers are still the biggest single paper coating item although more and more wax coatings are containing polyethylene or other resin to improve scuff resistance and prevent flaking. Polyethylene-wax blends containing up to 50% of polyethylene can be applied by roll coating methods using hot melts. Higher polymer content blends are applied by extrusion coating.

Perhaps one of the more important properties conferred on paper by the plastic coating is its low permeability to water vapor and other gases, in particular oxygen and carbon dioxide. This is especially true for packaging applications. Coffee for example needs a pack

which has good carbon dioxide transmission out from the pack and poor oxygen transmission. The pack must in addition be highly flavor and odor retentive.

Tables I-III list some recent measurements of oxygen, carbon dioxide and water vapor permeabilities of some representative plastic films together with some effects of humidity and temperature. In spite of the voluminous literature on gas and vapor permeabilities there is still a lack of reliable data especially as regards temperature and humidity dependence. We are presently engaged in filling in some of the gaps in our knowledge of permeability constants measured under a variety of precisely defined conditions. There have been reports that the permeability to water vapor of plastic coated papers is different according to whether the paper or the plastic surface is exposed to the humid side. This phenomenon is presently under investigation in our laboratories as it is of great interest to users of coated papers. The permeability constant is not an absolute value for the polymer but appears to vary according to the grade and method of manufacture of the film. The permeation process can be divided into the process of solution of the gas in the film and its diffusion through the film thus the permeability constant P = D.S. the product of the diffusion constant and the solubility.

TABLE I

Permeability of Plastic Films at 25°C.

units: ccs. gas/mm. thickness/cm²/sec./cm. Hg pressure difference x 10^{8}

Material	Oxygen	Carbon Dioxide	Water Vapor
Ethyl cellulose	0.80	4.75	510
Nylon	0.003	0.03	14
Polyethylene	0.31	0.62	0.6
Polyvinyl chloride	0.01	0.10	15.6
Polyvinylidine Chloride	0.001	0.03	0.15
Pliofilm No. (30°C)	0.037	0.128	2.08

TABLE II

Effect of Temperature on Permeability

(units: ccs/mm./cm²/sec./cmHg. x 10^{8}.)

	Polyethylene		Nylon		Ethyl Cellulose	
	Oxygen	Carbon Dioxide	Oxygen	Carbon Dioxide	Oxygen	Carbon Dioxide
Temperature °C						
0	0.07	0.68	0.001	0.003		
20					2.15	4.10
25	0.31	1.90				
30		0.004				
40					8.40	4.70
50	1.07	4.37		0.145		

TABLE III

Effect of Humidity on Permeability.

(units: ccs/mm./cm²/sec./cmHg. x 10^{8}.)

	Permability to Oxygen		Permability to Carbon Dioxide	
Material	0% RH	100% RH	0% RH	100% RH
Polyethylene	0.16	0.19	0.62	0.86
Nylon			0.006	0.059
Ethyl Cellulose			4.75	5.05

Note: Inconsistences in the results between Tables I-III is due to the use of different grades of film.

Laminated Papers

Laminates involve a special type of coating where a layer of paper is laminated to a second layer, which may be different, by the coating of a plastic adhesive layer on one of the paper surfaces. Thus the extrusion coating process can be adapted to laminating by feeding the hot extruded polyethylene film between two layers of paper traveling around the receiving rolls. Many specialty packaging materials are being made of such combinations as paper/plastic/aluminum foil or paper/plastic/cotton scrim and so on. Often a further coating of plastic is applied to give the combination heat sealing properties.

Laminated Structural Products.

Laminated assemblies made from layers of paper impregnated with resin and bonded by heat form the basis for a large and thriving industry. These laminated products are widely used in the electrical and machine industries for insulators, gears, pulleys and a multitude of machine parts. They possess high impact strength and toughness, are not subject to corrosion and have a dampening effect on sound, eliminating rattle and drumming in steel cars and machinery, good electrical insulation and dimensional stability. Furthermore they can easily be manipulated into complex shapes and can be drilled, turned and sawed. These properties make these products of great industrial value. They are also used in making trays, light flooring panels, table and counter tops and many other products.

Recent developments in this field include the use of polyester resins for low pressure laminating. These resins enable laminates for counter and table tops to be produced continuously by passing the assembly through a set of rolls and from then on through a heating chamber. The only apparent disadvantage to such a continuous process is that it is not possible to carry out cross lamination. To increase this saturating papers of almost equal strength in the machine and cross direction are used.

The addition of the resin to the paper at the pulp stage (beater addition) is being vigorously investigated from the point of view of laminates. Both polystyrene and phenol-formaldehyde have been added in the beater for laminate formation. In our own laboratory we have prepared phenolic laminates by beater addition containing up to 65% of resin. These could be laminated under heat and pressure giving products of similar strength to those prepared by saturation techniques. As with all beater addition resins the low retention was one of the chief difficulties encountered although percent retention increased as more resin was added (Table IV).

TABLE IV

Retention Studies on Beater Added Phenolics to Unbleached Kraft.

% Retention (β naphthol extracted)

% Resin Added		Correction after grinding
10	36.8	39.1
20	43.9	
30	51.0	54.6
40	53.7	
50	60.2	67.3
65	85.0	

M. Marander, M. S. Thesis, State University of New York, College of Forestry, 1951.

The determination of retention is difficult in the case of cross linked resins unless an element such as nitrogen, is present for analysis. Separate studies showed up to 7% more resin was tenaciously held by the fibers but were extractable on grinding. The corrected figures are shown in the last column of Table IV.

The precipitating reagent used was mixed acetic and phosphoric acids and the resin a water dispersed Durez phenolic resin containing 50% solids.

(Please turn to page 56)

Pyrogallol As A Reducing Agent

The process of metallizing a surface by chemical means depends on a number of factors to be successful. This paper reviews the use of pyrogallol as the reducing agent, which offers advantages commonly overlooked.

Samuel H. Wein

Bigelow Metallizing Chemicals Co.

THE USE OF PYROGALLOL as a reducing agent in making silver films used in making plastic (and other surfaces) electrically conducting for subsequent deposition of copper and other metals is not too well recognized. The information that is available to those who would like to work with the compound, is difficult to find primarily because the technical and patent literature is not readily accessible to those who might care to investigate this. In view of this, this paper presents a resume of the literature.

The use of pyrogallol as a reducing agent offers advantages not commonly known. Solution formulation is simple. And in several formulas cited it uses acid solutions instead of caustic alkalies, preventing the possibilities of silver fulminate (highly explosive) formation.

The first reference the author was able to locate regarding the use of pyrogallol as a reducing agent for the formation of silver films (in this case mirrors on glass) is that accredited to Stenhouse who in 1884 first attempted its use. This reference does not give further information on the method or use of pyrogallol beyond stating that the results were negative, i.e.; no silver mirror was formed.

In spite of this finding, the following review of the technical and patent literature indicates that the use of pyrogallol as a reducing agent certainly warrants further serious investigation and thought, and it is with that thought in mind that there is now reviewed in its chronological order the literature as recorded.

Chemical Facts: This chemical is sometimes called "pyrogallic acid" as well as trihydroxybenzene; the chemical formula is $C_6H_3(OH)_3$, it is white crystal, and readily soluble in water, with a specific gravity of 1.463. It is one of several common photographic developers used for better than 75 years. The present market price of pyrogallol from the manufacturers is in the neighborhood of $2.75 per pound.

Availability: Pyrogallol may be obtained from local photographic supply houses, primarily because it is used as a photographic developer. The following firms are known to be either manufacturers or chemical supply houses:

Baker Chemical Co., J. T., Phillipsburg, N. J.; Distillation Products Co., 755 Ridge Road West, Rochester, N. Y.; Eastman Kodak Company, Rochester, N. Y.; Mallinckrodt Chemical Works, 2nd. & Mallinckrodt Sts., St. Louis, Mo.; Merck & Company, Rahway, N. J.; Zinnser & Co. Inc., Hastings-On-Hudson, N. Y.

It must be borne in mind that the success of a good silver film depends much on the pre-treatment of the given surface (plastic, glass, etc.) with a dilute solution of what is now commonly accepted as a **sensitizer.** The various sensitizers have been reviewed by Wein. A suitable sensitizer may be made up of:

Tin chloride	20 grams
Water	1 gallon

To this solution there is now added sufficient hydrochloric acid till this "clears up", termed hydrolysis. If the hydrochloric acid is not added, the solution will become unfit for use the following day.

The technique used is first to wash the surface with running water, treatment with mild cleaning (alkaline) solution, again washing with running water, then treatment with the foregoing sensitizing solution, and again washing with running water. It is now ready for the deposition of the silver films by any of the techniques about to be reviewed.

Processes Reviewed: Farkas finds that pyrogallol will reduce the vapors of chromium chloride in an evacuated bulb to form metallic chromium. Subsequently hydrogen is introduced into the glass bulb to react with the converted metallic chromium.

Ow-Esschingen formed silver and gold films on rubber teeth which was subsequently electroformed with copper, by using a 2 percent silver or gold chloride solution and reduced by a 6 to 10 percent solution of pyrogallol.

In spite of the negative results of Stenhouse, Wehmhoff and Buck in the summer of 1930 reported that a representative of the United States Printing Office observed that the use of pyrogallol in making silver films in the manufacture of four inch copper letters had practical possibilities. These letters were used as master letters in the production of monotype matrices in the shop of the Monotype Corporation, in England, as developed by their metallurgist, Samuel Whyte. The work differs considerably from electrotyping in that letters were cut, not molded, in a thin sheet of wax adhering to a glass plate. There are no hair lines, rule work or deep recesses to cover as in the case of a wax electrotype mold.

Experimental work was started in the Government Printing Office, in October 1930. The wax case was dipped in denatured alcohol (in order to reduce the surface tension), then in a stannous chloride solution ("sensitizer"),

followed by rinsing in tap water. The solutions were applied to the case in the usual manner and the deposition of silver was complete in less than five minutes. The case was then rinsed in tap water and placed in the acid copper depositing tank. Covering with copper was rapid, requiring but one or two minutes. The principal difficulty appeared to be that the rules and hair lines were not sufficiently coated with silver, causing pin holes and cracks in the formed shells.

Trials using solutions of 33% and 50% of the amounts of silver nitrate given were unsuccessful, the silver film being so thin that the mold would not cover when placed in the acid copper bath.

The results in nickel deposition were not as satisfactory. The cases covered very rapidly, but wherever the silver coating was thin, or broken, splitting and curling of the nickel took place immediately, indicating that silver does not adhere to wax as firmly as does graphite.

The work was resumed in April 1932, using a silver depositing solution recommended by Mr. Whyte of the Monotype Corporation. This is an acid solution in which pyrogallol is used to reduce the silver. One advantage of an acid solution of this character is the elimination of the danger of explosion, which sometimes occur when alkaline ammoniacal solutions of silver nitrate are allowed to evaporate to dryness. The first experiments were made on half-tones molded in wax with molding graphite used to prevent the half-tone from sticking. Satisfactory results were obtained in several trials, but consistent results could not be obtained due probably to unequal deposition of the silver film.

Further experiments were made on a more difficult class of work, such as columns of figures separated by rules, since if good work could be done on that no difficulty would be presented in the case of type matter and half tones.

The following solutions were used in the series:

	Solution "A"		Solution "B"	
	Grams	Ounces	Grams	Ounces
Pyrogallol	7	0.93	25.0	3.34
Citric acid	4	0.53	2.5	0.33
Water	1 liter	1 gallon	1 liter	1 gallon

No appreciable difference could be noted in the results obtained with either of these solutions.

The silver solution itself consisted of:

Solution "C"

Silver nitrate	20 grams
Water	1000 c.c.

The equivalent of the foregoing silver solution is 5.35 ounces of silver nitrate dissolved in one gallon of water.

A frame was then placed on the case to hold the silvering solution in place, and the previously measured quantities of the two solutions mixed, and poured evenly over the case. The proportions of the reducing solution with respect to the silver solution are:

Solution "A" or "B"	300 c.c.
Solution "C"	100 c.c.

The equivalent of 300 c.c. is 10 fluid ounces and 100 c.c. is equivalent to 3.3 fluid ounces. This proportion of combined silvering solution is intended for use with a case of 13" x 24", the excess of the actual requirements in solution quantity will suffice for leakage around the frame. It is believed that with proper mechanical means of application, the quantity of solution can be materially reduced. The case was slightly agitated during the deposition of silver, which required but one or two minutes. Excess solution was removed by careful rinsing with water. After "stopping out" the case was again rinsed with water and this in turn was then ready for the deposition of copper or nickel.

The foregoing solutions were modified by the present author, and the silver solution consisted of a 4% silver nitrate in water. The reducing solution consisted of:

Pyrogallol	1.4 grams
Citric acid	0.8 gram
Water	200 mls.

The proper proportions between the silver and the reducing solution consisted of 2 mls. of the silver and 10 mls. of the reducing solution. An immediate mirror formed.

It is important to remember that these acid solutions all have a tendency to give rise to a hazy silver film which is considered unsatisfactory as a mirror, but this was not the case with silver films for subsequent electrolytic deposition as in the case for electrotyping, electroforming, etc. It is conceivable that this hazy film formation could be offset by the further introduction of organic solvents such as acetone and the various alcohols to the silvering bath.

Mason forms silver films on electrolytically oxidized aluminum by first treating it with a 10% silver nitrate solution to which a small amount of potassium hydroxide has been added, subsequently sufficient ammonia is then added to redissolve the precipitate first formed. The reducing solution consisted of:

Pyrogallol	2.5%
Hypo	2.5%

Gaut and Huggins recommend the use of ammoniacal alcohol solution with pyrogallol as the reducing agent, but give no details of solution formation.

Gavrilov coated the given surface three times with a solution of:

Silver nitrate	10 grams
Pyrogallol	3½ grams
Citric acid	2 grams
Water	1 liter

The silver film formed resulting from such a solution was then washed and converted into the corresponding sulphide by using the following solution for 1 to 2 minutes:

Sodium sulphide	30 grams
Water	1 liter

To improve the film further and to increase its strength, it was then treated with Vienna lime in a solution of sodium hydroxide containing 1% potassium cyanide. Then it was polished with a precipitated chalk containing potassium cyanide.

Dupois formed a lacquer film on the surface to be plated, a suitable compound recommended consists of:

Nitrocellulose lacquer	375 grams
Lithopone	75 grams
Thinner	280 grams

to this there now was added:

Copper powder	65 grams

and this was applied to the given surface by means of a spray gun in the conventional lacquer technique.

The film so formed was then treated with the silvering solution consisting of:

Solution "A"

Silver nitrate	20 grams
Ammonia	30 ctl.
Water	1 liter

Solution "B"

Pyrogallol	90 grams
Acetic acid	10 grams
Water	1 liter

(Please turn to page 56)

Prehardened Mold Steels . . . . .

. . . for the *Plastics Industry*

Birger L. Johnson
Latrobe Steel Co.

ALL OF THOSE WHO have had the experience of spending a great deal of time and money in the manufacture of a mold only to have it spoiled by excessive warpage or cracking during heat treatment are fully aware of the advantages to be gained by the use of a prehardened mold steel. One of our good customers told me not long ago that he had investigated the possibility of obtaining insurance against mold losses during heat treatment. The insurance firm which he contacted carefully checked into the risks involved and replied that they would be glad to write the insurance and that the premiums would amount to a large fraction of the mold cost. Naturally our customer did not buy the insurance. He felt that he could do better than 2 to 1 on the heat treatment and I am certain he did but the story, which is a true one, shows what kind of odds you are up against.

We know of only one satisfactory answer to this question and that is by the use of prehardened mold steel which places the heat treating operation where it belongs — prior to the manufacture of the mold.

We began looking at this important problem in our research laboratory about ten years ago. We set down at that time what we considered to be the basic requirements for a successful prehardened plastic mold steel.

1. We must have a clean high quality steel, free of defects.
2. The steel must be readily machinable at the prehardened hardness level.
3. It must be easy to polish to a high luster.
4. It must be uniform in hardness from surface to center.
5. It must have good balance between strength and toughness.
6. It must be easy to weld without damage to the properties of the steel.

When we measured the currently available steels against these basic requirements we found none that in our opinion would offer a satisfactory solution to the problem. So we decided that an entirely new steel must be developed and tailored to the specific needs of the plastics molding industry. We knew that we had to make a radical departure from the mold steels commonly in use. The air hardening steels such as the 5% chromium type are too difficult to machine at the prehardened hardness level. The oil hardening steels such as AISI 4130 and 6145 types have insufficient hardenability to obtain adequate hardness at the center of large blocks. The answer was eventually found in a so-called precipitation hardening steel. The specific steel which we developed is a nickel-aluminum alloy steel containing approximately 4% nickel, 1% aluminum, and 0.2% carbon. We named this steel Cascade.

Just what is a precipitation hardening steel and how does it compare with the more conventional, quenched and tempered types of steel? Metallurgically, precipitation hardening is nothing new and, in fact, is the mechanism by which beryllium-copper, an alloy commonly used for hobbed cavity molds, is hardened. In ordinary steels, hardness is obtained by adding carbon and then cooling the steel rapidly — that is, quenching from a relatively high temperature to form the hard constituent known as martensite. The steel is usually then tempered back to some intermediate hardness. In the case of a precipitation hardening steel almost the reverse is true. The nickel-aluminum steel, for example, is first cooled rapidly from about 1350°F, after which it is in the soft or solution treated condition, and it is subsequently hardened by holding for a long time at about 1000°F. The latter treatment is referred to as aging and takes place by the precipitation of a very fine almost sub-microscopic constituent within the microstructure of the steel, thus the name precipitation hardening steel.

Figure 1 shows a typical aging curve for the nickel-aluminum type of precipitation hardening mold steel where hardness is plotted as a function of aging temperature. It is evident that a maximum hardness of about 40 Rockwell C is attained at an aging temperature in the range of 975-1000°F. However, in order to obtain better machinability and a better balance between strength and toughness, the steel is usually over-aged to a slightly lower hardness level. Figure 2 shows a typical aging curve where hardness is plotted against time of aging, the time being on a log scale. Here it is seen that the hardness gradually increases to a maximum at about 20 hours, and with times in excess of this little hardness change takes place even up to very long periods of time.

How well does this precipitation hardening prehardened mold steel meet the six basic requirements which we originally laid down? We stated first that it must be a clean high quality steel free of defects. This factor is controlled primarily in the steel making practice. Generally speaking, if the steel selected for a mold is made to tool steel quality standards in small electric furnaces it will be inherently of relatively high quality. However, no commercial steel is perfect and an occasional imperfection will appear in the cavity surface during finishing which will have to be repaired in some manner such as by welding. Adding aluminum to steel increases the steel maker's problems and the precipitation hardening nickel-aluminum steel is somewhat more expensive to make, but with proper handling and careful inspection it can be produced to very high quality standards.

The second requirement we mentioned was that the

This talk was originally presented before the Western New England Section.

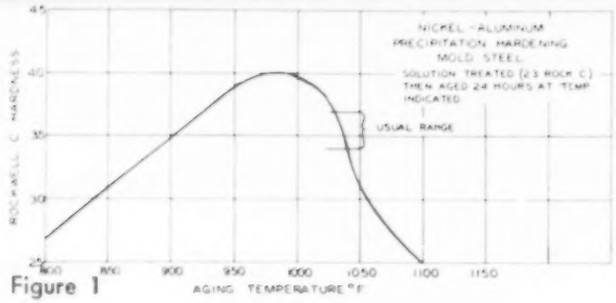

Figure 1

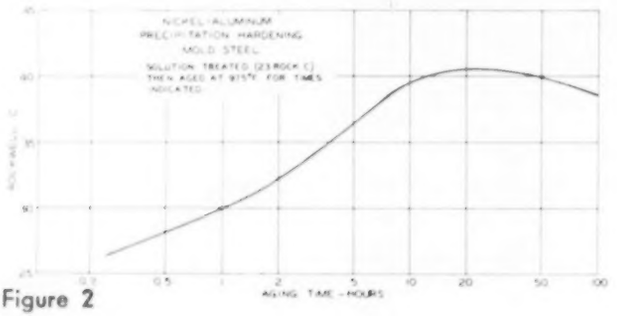

Figure 2

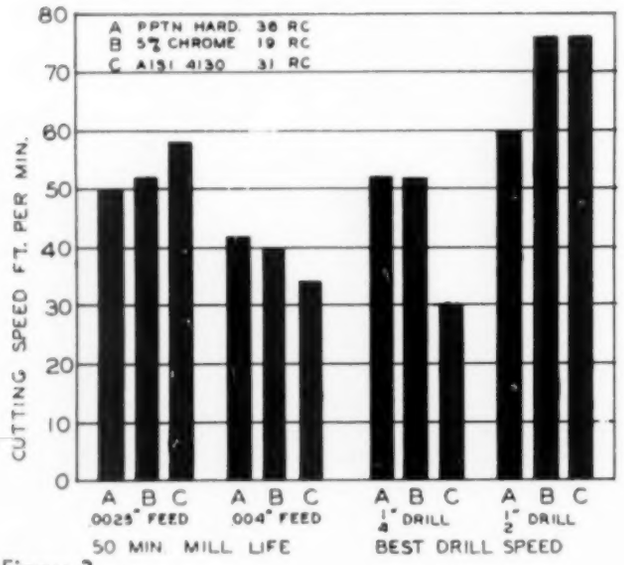

Figure 3

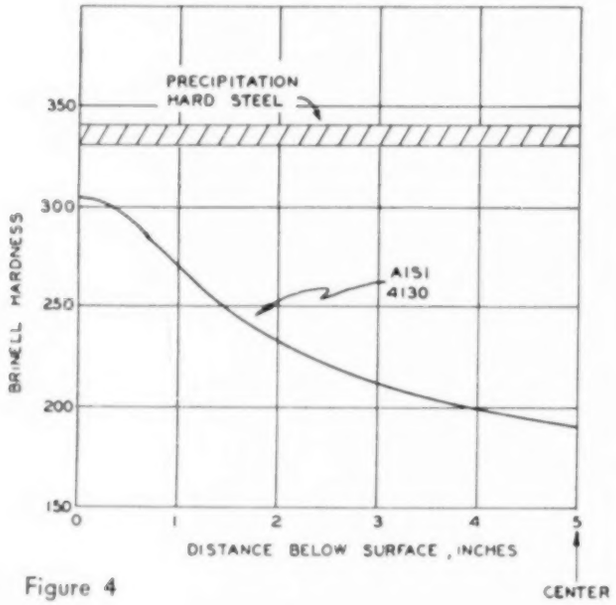

Figure 4

steel must be readily machinable at the prehardened hardness level. It is generally thought that machinability is pretty much a matter of hardness; that is, the harder the piece of steel the more difficult it becomes to machine. This is true to a certain extent but there are other factors which enter the picture so that one cannot anticipate machinability problems entirely on the basis of hardness. In order to obtain some actual machinability data for the prehardened mold steels, we have had fairly extensive machining tests run by an independent laboratory comparing two types of prehardened steels. (the AISI 4130 type[1] and the precipitation hardening steel) with a 5% chromium air hardening steel[2]. The precipitation hardening steel was tested at a heat treated hardness of 36 Rockwell C, the AISI 4130 type at its customary heat treated hardness of 31 Rockwell C and the 5% chromium steel at an annealed hardness of 19 Rockwell C.

Some of the results obtained have been summarized in Figure 3 in terms of comparative cutting speeds in feet per minute. Both milling tests and drilling tests are included. In the case of the milling tests, the comparison is on the basis of 60 minute tool life and for the drilling tests it is on the basis of recommended speed for optimum performance. In all cases it can be seen that the precipitation hardening steel compares very favorably, not only with the 4130 type steel at slightly lower prehardened hardness but also with the 5% chromium steel in the annealed condition.

We listed for the third requirement that the steel be easy to polish to a high luster. It is generally agreed among those skilled in polishing molds that it is easier to obtain a scratch-free polish the higher the hardness of the steel, although at the higher hardness levels the problem of metal removal is more difficult and the finishing operation usually takes longer to complete. Other factors than hardness, however, enter the picture in polishing, such as the uniformity of the steel itself. If the microstructure of the steel contains aggregates of soft particles and hard particles side by side, the ability to obtain a high finish with absence of orange peel effects and pitting becomes more difficult. From this standpoint, the microstructure of the precipitation hardening type of steel is particularly advantageous because of the mechanism of the hardening involved. Since carbon is not added to the steel to gain the necessary hardness, there are no hard carbides in the structure to cause non-uniform polishing conditions.

Uniformity of hardness, the fourth requirement we mentioned, is one of the outstanding advantages of the precipitation hardening type of steel. Again because of the mechanism by which precipitation hardening takes place, there is practically no mass effect during heat treatment and it is therefore possible to obtain the same maximum hardness throughout very large sections as can be obtained in relatively small sections. This is not true in the case of a quenched and tempered type of steel where the hardness is dependent on cooling rate during the quench with the result that the hardness near the center of large blocks is usually considerably less than at the surface. To illustrate this effect, hardness surveys were made on transverse sections cut from the centers of large bars of prehardened AISI 4130 type steel and a precipitation hardening steel. These bars were 10" x 24" in cross section and about 8 feet long.

(Please turn to page 54)

(1) 0.3% c, 1% CR, 0.2% Mo nominal composition

(2) 0.4% c, 1% Si, 5% Cr, 1.2% Mo, 1% V nominal composition

THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

Injection Molding Polyethylene

1. The Nature of the Beast

Many injection molders express surprise that anyone should have trouble molding polyethylene but many others have had experiences with it that indicate a review of their problems will be timely indeed. In one recent instance a molder's scrap rate reached 80% and he was forced to give up the job, leaving the problem unsolved. In another, Phil Arnoff of Transparent Specialties had just about reconciled himself to a steady 15-20% scrap rate on a given machine when Frank Kayman his molding superintendent finally traced the trouble to a coil that had a case of sporadic residual magnetism giving the machine an erratic overall cycle. When the coil was replaced, the scrap rate dropped to around 3%, largely shorts. The machine is working well beyond its rated capacity and is seldom troubled with black flakes or "dirt;" and while I am anticipating somewhat, it is just this kind of fallacy that makes the high and variable scrap rate with polyethylene so puzzling. On polyethylene we even see evidences that if a press is **over-rated** it actually may run with lower scrap rate than if it is under-rated—just the reverse of polystyrene!

There are several aspects to the polyethylene problem, ranging from the material, through design problems centered in the heating cylinder and nozzle, to the mold itself. All these factors are so closely inter-related that it is very difficult to separate them for discussion, and it must be borne in mind that any conclusions are fugitive and distressingly inconsistent. For example, Milan Krajcik of Wooster Rubber Company ran into such a high rate of rejects with a given batch of material that he pulled it from production. Some time later, he was forced to return to the "defective" batch, and for three days it ran almost to perfection. Then suddenly his scrap rate popped up again and he could not get it down, and he was forced to return the remainder of the batch to the material supplier!

The basic nature of polyethylene is that of a wax. The basic nature of polystyrene is that of a rubber. Any molder will tell you that a skin burn from polyethylene is more vicious than a burn from styrene. A little thought on this mundane observation shows that it is harder to put heat into and to take it out of polyethylene than styrene. The molding range of polyethylene is roughly, let us say from 300 to 600 degrees, or two to three times that of styrene. If we overheat styrene we get evidences of burning, discoloration, strains, sticking, and a variety of more or less immediate complaints. If we overheat polyethylene, we sometimes can actually improve the part finish, and while we undoubtedly force it to undergo a subtle kind of accelerated ageing, we have no **immediate** means of identifying this and it is difficult to state just what constitutes effective molding conditions for polyethylene. The education process is painful and costly. It comes in the form of warpage and peeling and uneven shrinkage that usually cannot be found till the molded goods are in actual use. The seriousness of the problem can be clearly seen, as a raft of improperly molded polyethylene articles reaching the consumer can have serious long term repercussions on all of us.

From the injection molder's viewpoint, there is not much that he can do about the basic nature of polyethylene. Problems of stabilizers, residual catylysts, anti-oxidants, melt index variation etc., all are beyond his control. When everything else has been eliminated, there remains a complex matter of chemical processing that requires exhaustive laboratory work, painstaking evaluation, followed by attempts to duplicate test results in large scale production. All these costly remote steps must precede the appraisal of the molding powder under actual shop conditions. Nevertheless, there are numerous aspects of the polyethylene material situation that bear directly on our immediate problem.

First, we must admit that the number of pounds of polyethylene that are injection molded comprise probably the smallest percentage of all uses of the material. From their ivory towers, material company executives see only miles and tons of sheet, film, pipe, wire, coatings, fabrications, etc., and comparatively few waste-baskets, box lids or other injected parts. Second, I'll wager that if you checked the records of an average supplier you would find that the injection industry is causing 90% of their complaints, and using only 10% of their output! Third, if you pick up a technical article on polyethylene, you will find pages devoted to countless applications (it is really wonderfully versatile stuff, this polyethylene) and only a paragraph or two to its use in injection molding. Fourth, there are more suppliers of polyethylene than of any other type of molding powder, and some of them know little if anything of the injection molding process. Fifth, there is far more variation between the molding powders supplied by all these manufacturers than there ever was in the polystyrene that was put out by the five or six major suppliers of that material. Sixth, experience shows that certain brands of polyethylene are far more suitable for injection molding than other brands. Seventh, even within the scope of requirements of one shop, certain molds and certain machines will perform best on one grade and one brand of material, even though that brand of material cannot be used on any other jobs that are being run in the given shop.

Even this cursory survey of the problems the injection molder faces with his raw material indicates their baffling nature. The only practical solution to date has been the keeping of very accurate production records relating to brand and batch of material; and by trial and error determining what mold and what machine are best suited to a given brand and melt index. Then all one can do is pray that the manufacturer will be consistent, and that subsequent lots will duplicate previous ones—which they may not, even though the melt index and other tests PROVE they are the same.

I suspect that much of our trouble stems from the fact that the injection process is intermittent in nature, and that the material moves in successive stages through the heating chamber. And it is the heating chamber that we will discuss next month.

PROGRAM

"Plastics Progress Presents"
SPE 12th Conference

See page 30

AROUND THE WORLD

FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

July-August, 1955

Abstracter: Hans Mayer

GLASS-REINFORCED PLASTICS IN THE AIRPLANE INDUSTRY—P. Fleuriel

The use of glass reinforcements in airplane building depends on technical as well as economical considerations. Economically the question of cost, technically the question of weight saved are of prime importance. Finally the case of such applications where other materials would not work as in radar housings will determine the scope of use of glass reinforcements. Based on these considerations the author investigates a large number of applications as used on the Vautour Jet Fighter.

AN INJECTION PRESS FOR LOW PRESSURE INJECTION OF POLYETHYLENE and POLYVINYL

The machine described is basically a transfer or injection press with low pressure plunger action. A series of molds is arranged on a circular table, one mold at a time being lined up with the nozzle of the injection cylinder while the other molds are being cooled to permit the material to set or to be unloaded. The plastic material is rather extruded into the mold than injected. The molds are aluminum castings.

GERMANY

KUNSTSTOFFE

September, 1955

Abstracter: Anne Schwend

IRREVERSIBLE THERMAL REACTION OF SOLID ORGANIC INSULATING MATERIALS — C. Reimer

A number of examples of different testing methods explains the irreversible changes of properties of solid organic insulating materials. Aside from customary checking, also tensile and elongation diagrams, loss in substance and thermal dependence of the dielectric loss factor tg δ after previously defined heat induction periods have been investigated. These tests reveal the structural changes taking place through thermal influence.

Acquaintance with the irreversible point of one particular property, f.i. the loss in substance, does not suffice for stipulating approximate temperature limits, but should be enhanced by knowledge about as many properties as possible. It is of great importance, but often very difficult to define the permissible end-values down to which the properties may be reduced through heat for specific purposes. Thorough acquaintance with operating conditions is required to this end. Observation of certain conditions will help to stipulate temperature limits through determination of the irreversible temperature reaction of individual insulating materials without having to try out the performance of entire machines and apparatuses, which, however, constitutes a valuable supplement.

HIGH POLYMERS — Dr. Ottmar Leuchs

Part 2 of this article holds a list showing the main properties of high polymers which were subdivided into 8 groups: polyenes, polyethers, polyesters, polyamides, aldehydes, other organic high polymers, semi-organic high polymers (polysilica ester, silicones), anorganic high polymers.

For each product within these groups the list specifies: a—basic material; b—kind of polymerization; c—chemical designation; d—chemical formula of group features or of low molecular constituents imbedded in thermoplastics; e—customary cross-linking agents; f—intermolecular forces; g—main trade-marks; h—explanations. This specification only lists pure polymers. Co-polymers or modified and graft polymers will be mentioned in an alphabetical list to follow.

PRE-CONDENSATION OF EPOXY RESINS — Dr. P. Bruin

Some new developments all basing on the principle of formation of adducts and pre-condensation of lacquers prior to their use have contributed to an amelioration of flow and surface-finishing properties of cold-hardening and annealing lacquers on the basis of epoxy resins. A description of different ways of obtaining adducts and precondensed products follows. Properly prepared precondensates may be stored indefinitely. Pre-condensation also constitutes a means of achieving compatibility between epoxy resins and phenol formaldehydes.

STYRENE ACRYLO NITRILE CO-POLYMERS—J. S. Whitaker

Abstracts from SPE Journal, May 1954.

MODERN APPLICATIONS FOR MODIFIED STYRENE SHEET — R. F. Hrudka

Reprint of paper presented at 11th Annual Technical Conference of SPE.

DESIGN OF INJECTION MOLDS—Hans Gastrow

Description of tang break-off tools for tubular parts without internal threads and parts with molded-in metal inserts.

TROPICAL TESTS OF PLASTICS IN THE AMAZONAS TERRITORY — Manfred Rauschert

Preliminary results of tropical tests with different plastics such as PVC and polyethylene films, laminated PVC films, Saran tissues and films are communicated.

October, 1955

NEW POLYETHYLENE — Georg Schulz and Karl Mehnert

The physical, chemical, electrical and physiological properties of "Hostalen," low-pressure polyethylene of Farbwerke Hoechst are discussed. By observing certain conditions during polymerization, products suitable for customers' needs and intended processing may be supplied. Processing and applicability shall be discussed in another article.

POLYAMIDE PARTS OF UNIFORMLY MORPHOLOGICAL STRUCTURE — W. Hechelhammer

Description of various tests aimed at obtaining pre-determined structural properties in polyamide parts: tempering between melting point and 5°C. above this point will result in uniformly granular structure after cool-

ing. Raising of tempering temperature above this point will favour spherulite formation, spherulites growing proportionally with increasing temperature. It's up to the producer to influence structural properties according to needs. Since practice demands direct production of parts of desired structure, pre-requisites for polyamide extrusion and injection molding are discussed. Too little is known to date about ratio of amorphous to crystalline components, stresses caused by different chilling conditions, moisture content, factors which co-determine final properties of product aside from physical structure, effect of which, though, has not been unequivocally stipulated yet.

STATIC ELECTRICITY AND ITS EFFECTS — Heinz Haase

Neutralization of static charges was rather neglected in the past. Fighting the disadvantageous and often dangerous effects of static charges necessitates unveiling of causes first. New gauges such as the "Statometer" (a case with a tubus in front in which a piece of radioactive ionotron film ionizes the air, ion distribution being influenced by an electric field) help in discovery and measurement of static charges. Grounding of all metal parts, proper choice of abrasives, coating with finishings or electro-static neutralizers, above all careful air-conditioning of workshops represent remedies. Description of different neutralizing methods is followed by brief sketch of useful application of static electricity.

HIGH ENERGY IRRADIATION OF PLASTICS — Paul Namur

Based on U.S. literature, a survey of advances of nuclear physics into the field of plastics is given. Radiation kinds and sources as well as their effect, sundry types of accelerators, changes in the molecular structure, cross-linking and structural deterioration brought about by certain radiation doses are viewed.

INJECTION AND TRANSFER MOLDING OF RIGID PVC — Dr. G. Wick and Dr. H. Konig

Joints and fittings for extruded plasticizer-free PVC tubes have so far been either machined or molded or were substituted by nonferrous metal parts. High production cost for these promoted the adaptation of injection and transfer molding methods to requirements. Parts up to 18 oz. in weight may be injection molded, any larger parts are transfer molded. Injection molding demands specially designed plasticizing cylinder holding not more than two to five times the amount of polymer needed for one shot, with strainer in front end of cylinder. Polymer is heated to 10 to 20°c. below actual flow temperature and by pressures higher than 21,335 psi is pressed thru constriction and nozzle into the preheated mold. Exposure of polymer to good flow temperature is thus very brief, hence permits injection molding of polymers the molding temperature of which coincides with their decomposition temperature.

For transfer molding the polymer is preheated in an oven or plasticized in an extruder, then fed into a recipient preheated to flow temperature of the thermoplast. This recipient is set on preheated mold. A press plunger forces the plastic thru a nozzle into the mold. Filled mold is withdrawn from press and cooled only so much that outer skin of the molded part freezes but mass remains above second order transition point. Cores may easily be withdrawn then and parts are cooled in several baths of successively lower temperature. Advantage of this method: molding at flow temperatures and low pressure which produces heat resisting parts. Principle of this method: assigning defined functions to each aggregate used and excluding interruption of flow of material, thus eliminating the danger of separation of hydrochloric acid.

CREEP STRENGTH OF SOME HIGH POLYMERS — K. Richard and G. Diedrich

Results of creep strength tests with polytrifluorochloroethylene and polyethylene reveal the time extension and time rupture limits under static loads, knowledge of which is essential when using such materials as load-carrying elements.

DRYING OF HYGROSCOPIC PLASTICS — Heinz Haas

While non-hygroscopic plastics do not bind moisture and may be dryed in circulating-air dryers, the content of moisture in hygroscopic plastics, particularly caprolactam and cellulose acetate, is bound by rest valences and capillary forces from a certain degree downward, hence demands drying under vacuum. Mechanism of sorption is explained the same as the deleterious effect of retained moisture. Theoretical considerations of the drying process are followed by brief description of vacuum tumbling dryers with condenser and evacuator for polymerized caprolactam and vacuum blade dryers for cellulose acetate, these two dryers being representative for high and partial vacuum dryers.

AUTOMATIC CONTROL OF HYDRAULIC PRESSES AND INJECTION MOLDING MACHINES — J. Krause

Advantages and disadvantages of water and oil hydraulic control systems for compression and transfer molding machines as well as injection molding machines are debated along with safety devices, circuitory systems and economic aspects.

SYNTHETIC RESIN DIES — K. Meyerhans

Development of principally epoxy resins as substitute for non-cutting metal shaping tools and wood and gypsum gauges and patterns has been pushed so far that unskilled personnel can be employed in die, gauge and model-making, delivery times and cost reduced, metals saved, non-corrosiveness as well as many other favorable factors suggest application of epoxy resins for these purposes. While the U.S. automobile industry concentrates on gauges and models, plants in Europe attempt to partly or completely substitute metal by synthetic resins. A resumé of application possibilities and compounds used (phenol formaldehyde condensates, polyester and ethoxylene resins) is followed by details on processing methods and structural designs (glass fibre reinforced laminating, reinforcement of shell structure, casting including the Briggs' test methods, new resins, fillers and hardeners by Ciba, Basle, reducing shrinkage during curing to practically zero provided cure temperature does not exceed 30°C., use of ethoxylin resins as binders in tool-making and binding hard-metal coatings to steel cores, etc.)

PLASTICS IN FOUNDRY PRACTICE — R. Walter

A compendium on plastic binders for foundry mold-making and details on the J. Croning method for mold-shell construction.

NOVEL WIND-UP EQUIPMENT FOR BLOWN AND CALENDARED FILMS — W. Schmitt

Recently developed machines are presented: a) incorporating devices for landing, keeping width of film, cutting and winding; b) incorporating two to four wind-up rolls supported by reversing slides. Whether the latter machine with its fine film guidance and ingenious exchange of full against empty rolls will prove satisfactory during continuous operation will have to be seen when test results are available.

EXPERIENCES WITH THE "KO-KNETER" — J. Aeschbach

Novel equipment developed for the "Ko-Kneter" mixer - kneader - plasticizer: shaft of graduating diameter for high bulk factor plastics and difficult homogenization tasks, double heating and cooling of shaft and experiences gained with weigh-feeding device with hopper automatically retracting in case of excessive feeding, temperature control, four different granulators and general experience with sundry plastics.

DC TESTER OF PLASTICS POROSITY — W. Becker

Hitherto used high frequency spark inductors for AC have been substituted by high tension DC testers for checking plastic linings as to possible faults, thereby increasing safety of operation for workmen considerably.

PROCESSING OF POLYVINYL CARBAZOLE — H. R. Jacobi

Machining, compression and injection molding, extrusion methods for polyvinyl carbazole are discussed. A chart discloses reaction of polyvinyl carbazole at various temperatures and resistance against different corroding agents.

EXTRUDED PLASTIC TUBES — G. Schenkel

A survey of known methods is followed by discussion of new centering and calibrating equipment for extruders. Centering is based on radial displacement of calibrating tube which is in direct contact with the orifice, the diameter of the calibrating tube being greater than the inner diameter of the orifice. A floating stopper is used for blocking the interior of the tube against uncontrolled escape of air. Continuous gauge control is effected by radioactive radiators fastened directly to mandrel of extrusion head with radially adjustable orifice, radiation emitted being absorbed by one or more gauge controls after having passed thru tube walls. In extrusion heads with inadjustable mandrel and orifice and radially displaceable calibrating tube, radiator is fastened to floating stopper.

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GREAT BRITAIN

PLASTICS

Sept., 1955

Abstracter: Alfred T. Rexer

THERMOPLASTIC SHEET PRODUCTION

This article describes three methods of sheet manufacture up to widths of 5 ft. They are sheets molded from powder of special particle size, in steel "picture frame molds;" lamination of calendered sheets; and the use of extruded sheets by a similar lamination process. It is well-illustrated and covers press details, control, molding operations, and applications.

THE PROPERTIES AND TESTING OF PLASTICS MATERIALS — A. E. Lever

This article covers thoroughly the various methods of testing the hardness of plastics. Tabular and bibliographical information is included.

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ITALY

POLIPLASTI

Abstracter: A. L. Alk

ISOFLEX: A NEW INSULATING MATERIAL — by Manlio Muzzoli and George Anglesio

Isoflex is a thermal insulation produced from corrugated sheets of plasticized cellulose acetate. The sheets are heat sealed together with the corrugations of alternate layers at right angles to each other. The density of Isoflex is about 11 kg per m3 and it has a thermal conductivity of about 0.04 kcal per mh°C. It absorbs less than 1% moisture at 100% relative humidity in an ambient temperage range of 30 to 70° C. It is recommended for use where movement and vibration might be a factor. The warm side of Isoflex must be protected with a moisture barrier and the cold side with a permeable membrane of wood or perforated metal. A specially interesting application is transparent Isoflex used for industrial glazing. The article claims that the glazing provides as much insulation as the adjoining factory walls.

PIPING IN SYNTHETIC HIGH POLYMERS —Andrea Melicchia

The field of industrial piping with various types of polymers with particular reference to U. S. consumption and manufacturing is presented as a preface to a comprehensive listing and description of standards and test methods published by appropriate organizations in the U. S., Germany, France and Great Britain. The aims and present work of Technical Committee 5 of the International Standardization Organization and associated committees are discussed. Proposed standards are offered for "Dimensions of PVC pipe Provisional Standards and Projected Test Methods for PVC Piping and Fittings for Potable Water Distribution" and "Provisional and Projected Test Methods for Polyethylene Piping for Potable Water Distribution." A discussion follows of the activities of the sub-committee in its last meeting in April 1955 at The Hague prior to submission of the documents at the ISO meeting at Stockholm. The article closes with the activities of the Italian groups studying these standards and a summary of some of the results of their work.

"CRAZING" IN METHACRYLATE RESINS — Giovanni Antonioli and Alfredo Turchetti

Crazing, characterized by haze and fine cracks, is a phenomenon found to some extent in all thermoplastic resins. Especially in transparent polymethylmethacrylate the phenomenon causes degredation of the optical properties and severe reduction in resistance to mechanical stresses. It is caused by continued stresses, solvents, ultra violet radiation or combinations of these factors. Crazing is described in detail and a test procedure is presented for determining the relative craze resistance of selected samples. The mechanism of crazing is discussed and the effect of the several stimuli on the Van Der Waals forces are examined in some detail. Finally a number of directions are given for minimizing crazing in polymethylmethacrylate.

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SWEDEN

PLASTIC ASSOCIATION TECHNICAL BULLETIN

Vol. 10, No. 3, Jan., 1955

Abstracter: Walter Werber

Volume 10, No. 3, January, 1955

COLORING OF PVC—C. Musgrave

This article deals with the properties required by colors in order to withstand the conditions during the processing of PVC. Emphasis is placed on so-called heat stability, absence of migration, light stability, etc. The author uses tables and charts in detail to describe the coloring techniques.

Volume 10, No. 4, January, 1955

SOME POINTS ON FIRE RISKS IN THE MANUFACTURE, PROCESSING AND USE OF PLASTICS — Bjorn Oestlin

A comprehensive survey is made on fire risks in connection with the manufacture of plastics and the secondary types of processing, adding of plasticizers, fillers, lubricating agents, etc. The conclusion is drawn that the public does not know about plastics in general, and should be educated along these lines.

Volume 10, No. 1, January, 1955

EFFECT OF VARIOUS ADDITIVES ON UNSATURATED POLYESTER RESINS—B. S. Bernitson and L. Turunen

Volume 10, No. 5, February, 1955

DIFFERENT PROBLEMS IN EXTRUSION—Ing. Reifenhauser

The author discusses in detail different types of nozzles and some aspects of sheet and tube extrusion.

Volume 10, No. 6, February, 1955

APPLICATION OF UNSATURATED POLYESTER RESINS — Bryan Parkyn

The author discusses glass fibre reinforced plastics and its importance for industrial applications, because of its many useful qualities, such as light weight, high impact strength, etc. The paper deals with a great number of manufacturing methods for these unique resins, particularly with those that apply to the single part mould. A number of actual manufacturing problems are discussed in detail and a cost analysis is added in the end.

Volume 10, No. 2, February, 1955

THE FREEZE THAW STABILITY OF POLYVINYL ACETATE EMULSION PAINTS—A. C. Fletcher and J. E. O. Mayne

The tendency of P.V.C. Acetate paints to coagulate is discussed and useful hints are given for the manufacture of these paints. Several types of additives are discussed and its trapping rather than packing the mold; and cooling before ejection to assure a minimum of stress.

SPEAKING OF EXTRUSION

Edited by R. D. Sackett

Technical Service Associate
Monsanto Chemical Company
Springfield, Massachusetts

The Importance Of Temperature Measurement In The Extrusion Die

By M. Underwood
Research Engineer
Monsanto Chemical Company

Extruder operators making sheet, film, and profiles, are generally pretty careful people. They have to be. In today's competitive market, the product has to be right on the button. Operating conditions are carefully watched to make sure that everything is running properly, and as little time as possible is spent making scrap. Therefore, it is surprising to see many operators overlook the help they could get from two simple measurements: temperature of the melt as it enters the die, and the internal temperature of the die.

There are only four independent variables in the operation of an extrusion die with a given material: the flow rate of the melt, the internal shape of the die, and the two temperatures mentioned above. The effect of flow rate, by itself, is relatively minor. The effect of mechanical changes in the internal shape of the die is a subject in itself. Other effects sometimes measured, such as pressure, bear no simple relation to the performance of the die. Temperature measurement is therefore the subject of this article.

It is nothing new to say that temperature control is important in extrusion operations. Anyone who has ever tried to run an extruder knows it. The trouble is that there are so many temperatures to measure, and it is hard to say just what effect a change in any one of them will have on the operation. There may be a dozen temperatures routinely measured between the hopper and the die lips. Because of this complexity, the trial-and-error method of control is used.

Trial-and-error does work. It often works very well. The trouble is that it costs so much in machine time and scrap, and there is no assurance that the best possible rate of production has been reached. Also, one learns so little that can be applied to setting up the next job, or can be used when moving the job from one machine to another.

When changes in barrel temperature, hopper temperature, screw cooling water, and screw speed are recognized as means for controlling the melt temperature, the problem is simplified greatly. True, these factors also control other aspects of extruder operation, such as mixing and devolatilization. Smoothest operation is obtained however, when adjustments are considered first as they affect melt temperature, and then only secondarily as they affect other aspects of operation.

Perhaps the importance of melt temperature has been overlooked because it cannot be measured by ordinary means. Sometimes an operator will use a needle pyrometer to measure the temperature of the melt as it issues from the die. This may be helpful. Usually, however, the temperature has been changed so much by the die itself that the reading is of little value.

Die temperatures are measured and controlled too, but too often the wrong temperature is measured. Obviously, it is the temperature of the metal in contact with the plastic melt that is important. The temperature most commonly measured, however, is one on the outer surface of the die, near the heaters. The control instrument measures and indicates it while regulating the flow of current to the heaters. As a supplement to this information, the temperature of the die lips may be measured with a hand pyrometer. Both of these temperatures bear some relation to the internal temperature, but just how close or far apart they may be is difficult to guess.

A word of caution at this point. Don't jump to the conclusion that just because the internal temperature of the die is the important one, the controller thermocouple should be located deep within the die. That is an attractive thought, but it won't work. The response lag will give you a bad "hunting" situation, instead of the rock-steady temperature control you need.

With only the ordinary temperature measurements available to the operator, a completely incorrect picture of the operation can easily be obtained. The temperature differential between the melt and the die may decrease 80 or 90 per cent as the melt passes through. Thus, an initial difference of 25°F may wind up as 5°, which is about as close as the ordinary pyrometer can be read. Was the entering melt therefore hotter, colder, or the same as the die? The operator can't tell.

Add the temperature change in the stock to the variation throughout the die, and the confusion is complete. Ordinary pyrometer measurements, for example, might show the die to be 380°, and the stock 390°. This would indicate that the entering stock temperature is considerably hotter than the die. Yet the internal die temperature might be 395°, and the entering melt 370°, quite the opposite of the apparent condition. From such measurements nothing at all is learned of the very important operating condition, the **relative** value of the two temperatures.

It is really quite simple to measure the actual values of interest. The die temperature should be measured deep within the metal. A hole for a thermocouple can be drilled midway in the die, with the bottom about ¼ inch from the flow channel. A convenient type of thermocouple has a spring which presses the junction firmly against the bottom of the hole. A bayonet connector makes it instantly removable, and a flexible armoured sheath protects the leads from damage.

There should be at least one temperature measuring point for each zone of the die that is separately heated and controlled. Intermediate points are very useful when originally setting up the die because they will show up troublesome irregularities in temperature distribution, but they are less important later.

The melt temperature should be measured as it **enters** the die. The problem here is to make sure the thermocouple actually indicates the stock temperature, rather than a distorted version of the wall temperature. It is necessary to use a probe long enough, and slender enough, to minimize the error due to conduction of heat along the probe.

There are probes commercially

(Please turn to page 51)

SECTION NEWS

Edited by

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Western New England

Charles H. Dugliss Gives Talk On Reinforced Plastics Field

George Snyder

Reinforced plastics, what they are and how they're made was the topic up for discussion at the November 6 meeting of the Western New England section. The 60 members in attendance heard Mr. Charles H. Dugliss give a down-to-earth talk on the properties and prospects of this fast-growing field of plastics technology. Mr. Dugliss is Assistant Group Leader, Reinforced Plastics Group, Plastics and Resins Section, Research Division, American Cyanamid Company, Stamford, Conn.

Mr. Dugliss stressed the importance of know-how in the formulation phase of premix compounds used in reinforced plastics molding, stating that a knowledge of ingredients and how they affect the results that may be obtained is the real key to mass production of reinforced plastic parts. The term 'premix molding compound' merely means that the filler is present in a discontinuous state and that all the ingredients of the compound have been blended prior to the addition to the mold," said Mr. Dugliss.

The basic types of premix compounds currently in use include 1) compounds prepared by the molder using a mixer process, 2) compounds prepared by the molder using a continuous process, 3) proprietary compounds of the mixer process type, and 4) proprietary compounds of the continuous process type. Each type, while basically similar, has distinctive advantages to the molder and the choice of which to use depends upon the part to be molded and the end-use requirements of the application. By and large, Mr. Dougliss said, compounds prepared by the molder in the mixer process afford a greater degree of versatility in production. Inplant formulation and mixing may be easily accomplished by using a simple mixer, there being a number of types available in various price ranges. A glass fiber cutter, to vary the length of fiber used, is also desirable but not essential, he added.

While the procedure for adding the raw materials to the mixer varies according to materials used, Mr. Dugliss explained, the usual procedure is to add the resin and catalyst or the catalyzed resin to the mixer, and then add the reinforcing and non-reinforcing fillers simultaneously. It is important that the mixer be operating during the loading phase, he said, and mixing is then continued for five to 30 minutes, depending on the size of the mixer.

After mixing the compound, it should be stored under refrigeration in a closed container, Mr. Dugliss emphasized, to prevent loss of monomer through evaporation. Serious mold fouling might otherwise result, he said.

The continuous process technique requires an impregnating tank and a wet roving cutter, but otherwise the basic procedure is very similar, Mr. Dugliss said.

The choice of resin to be used in premix molding compound is very broad, according to Mr. Dugliss, and he mentioned a number of possibilities, such as styrene, diallylphathalate, and triallylcyanurate resins, each of which has its own peculiar advantages. As a general rule of thumb, he advised the selection of a resin which has a low viscosity-temperature index to attain uniform distribution of the reinforcing filler in the molded piece. This is especially important when the piece is of large dimensions and considerable flow of the compound is required to fill out the cavity. Viscosity may vary from 20 to 300 poises, he said, but viscosities below 20 poise are not recommended for this process.

In his discussion of filler types, Mr. Dugliss listed a number of readily available materials such as glass fiber, asbestos, sisal, ramie, chopped nylon, canvas and synthetic fibers. Again, he said, the choice of filler is determined largely by the type of part being molded, its end-use function and other production factors which vary from one situation to the next. Reinforcing filler content of mixing process premixes vary from 0% to 60%, the usual amount being about 20%.

The non-reinforcing fillers also present a wide choice of materials, including clay, calcium carbonate, silica, talc, calcium sulfate, and various others. Almost any inert material, except those of alkaline content, may be used. Critical factors to be considered, however, are the oil absorption number and particle size. Oil absorption affects viscosity of the mix, and small particle size is necessary to prevent "filtering out" of the ingredients.

Benzoyl peroxide is the most widely used catalyst, Mr. Dugliss said, but a number of catalytic systems are available. Inhibitors, such as hydroquinone, may be used to increase stability of the compound, and internal lubricants are sometimes added though not required.

In the molding phase, presses used should be fast-closing to minimize the possibility of pre-gellation of the compound, but should be adaptable to slow closing in the event the compound has low viscosity. Pressures in compression molding usually range from 50 to 500 psi.

Aluminum or magnesium molds may be used for the production of low runs up to 1,000 parts, but for larger runs polished or chrome plated steel molds are required. In either case, molds should be cored for heating by steam or hot oil, Mr. Dugliss said. Breathed cycles are not required in this process since the release of volatiles is not a problem, he added.

Mr. Dugliss concluded his talk with a brief discussion of the future prospects for reinforced plastics. Mr. Harold MacVicker of American Cyanamid Company's technical sales group assisted Mr. Dugliss in this portion of the presentation, and described a number of sample parts which are currently being molded for industrial uses in this field. On display were military aircraft components, radomes, electrical parts, hammer handles, refrigeration parts, automotive heating and ventilator duct systems, auto interior window frames and radio frames.

A demonstration of mixing the premix compound and subsequent molding of a sample item was made before the group during a question-and-answer period.

A biography of the late Edwin Bertsche appears on page 47.

Newark

Corbett Speech Has Big Turnout

Robert Bostwick

The regular meeting of the Newark Section on November 9 had a good turn-out of 127 members and guests for the dinner. Table favors were supplied by Plastic Molders Supply Co. of Fanwood, N. J.

Society business included announcement by Pete Simmons that the Newark Section had been honored in having Bob Bartlett made National Chairman of the Education Committee. Bob is certainly well qualified for the position. Also Dor Biklen announced that the annual Christmas dinner-dance had been set for December 14.

The evening program started with a new Bakelite sound film entitled "Molding Phenolics." This was the first showing in this area for this film, which was introduced by R. L. Rasmussen. The film covered phenolic molding from tabletting through different types of molds and molding techniques to excellent animation sequences showing what happens to the molding material inside the mold.

The second feature of the evening was a talk on "Extrusion of High Impact Polystyrene Sheet" by Herbert O. Corbett, Chief Engineer, Extrusion Division, Auburn Button Works. Mr. Corbett related some of the experiences at Auburn Button Works, which was one of the first in this field, and showed a number of interesting pictures of the operation. He discussed some of the problems in the extrusion of this material and touched on the use of take-off rolls heated to 150-200 F. Higher roll temperatures are used for thicker sheets. Auburn is presently producing sheets up to 239 mils in thickness. Mr. Corbett recommended a 4½" extruder and a 4" lip land length for the die.

Door prizes were donated by Bestway, Inc.

The Section is voting for three new Directors from a slate of six nominees —Dennis Mullins, William Bradbury, Edward Koplitz, Ernest Csaszar, Louis Quintoni and Ernest Hanson.

Pacific Northwest

Quality Control Subject Of Talk

R. A. Fulton

Mr. Gordon Campbell, Statistical Quality Control, Boeing Airplane Company, spoke on the subject of "The Philosophy of Quality Control." As Mr. Campbell stated, it was most difficult to crowd what is learned in a ten week University Seminar Course into approximately a half hour talk. However, it was evident that each and every one there was extremely interested in his very excellent discussion regarding the importance of maintaining a system of quality control and how to evaluate your own company's procedure and practices, materials, etc., using the basic concept of control of variables.

There was considerable question and discussion both during and after Mr. Campbell's talk indicating the high degree of interest by those present.

For those who are interested in learning more on this subject the following book has been recommended by Mr. Campbell. A McGraw-Hill Publication entitled: Statistical Quality Control by E. L. Grant.

Mr. Campbell indicated that this book was probably available in most public libraries.

New York

Symposium, Talk Highlight Meeting

J. Dugan

"Materials Handling" was the subject under discussion at the October 19 dinner meeting of SPE's New York Section, held at the Gotham Hotel in New York City. As an added feature, the meeting was opened with a short talk by D. G. Welsh, Hercules Powder Co., on Hercocel W, a new cellulosic thermo-plastic molding compound for cutlery handles, telephone bases, fountain pen barrels, etc. Advantages, limitations, molding qualities, and applications were covered.

Following the Hercules presentation, the meeting was turned over to the symposium, which was moderated by Irvin I. Rubin, Robinson Plastics Co. The first speaker was George Smith, I. B. M. Corp., who covered "How to Get Started in Materials Handling." Using actual case studies to illustrate his talk, Mr. Smith discussed in broad terms the general principles behind setting up a system to save time and money by the judicious use of available manpower and space.

"Fundamentals of Equipment Selection" were discussed by G. Raymond, Jr., Raymond Corp., with special emphasis on the mechanized handling of materials in their three basic forms; solids, liquids, and gases. In each case, he described the proper equipment to be used, when to use it, and how to use it. A discussion of individual problems and possible solutions followed the talks.

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Dear Friends:

We are rapidly approaching the time for the 12th annual Technical Conference of the SPE. For some reason, I am looking forward to this one with even greater anticipation than in former years. Perhaps this is because we have noted an increasing awareness of the responsibility falling on Engineers of the Plastics Industry. We see evidence of this growing stature when persons like Mr. Joseph Finger, Corrulux Div., LOF Glass Fiber Company make the statement: "anybody who tries to jump in the market prematurely without having a well designed and engineered and fabricated product is in for a quick dollar and quick bankruptcy." As Engineers of the Industry, we must be absolutely certain that we have engineered products which receive favorable public reaction.

With Christmas also close at hand, the thought occurs to me that it is the little things that give the most encouragement. One of these is the opening of the 12th Conference with an invocation by a Minister. I believe this is only the 2nd conference to do this. I do hope that these little messages also make you more aware of the part you can play in strengthening the Christian Principles upon which our individual and collective welfare is based.

Yours for better living with plastics,

Wayne I. Pribble

WAYNE I. PRIBBLE, President

Rhode Island And S.E. Mass.

Section Plans To Start School For Foremen; Elects Directors

Glenn A. Tanner

The November meeting of the Rhode Island and South-East Massachusetts Section was held Tuesday, November 22, 1955 at Wayland Manor, Providence. The management of the hotel served 38 members the usual excellent dinner, this month delicious roast beef. After the dinner, President Miles Powell, Jr., E. I. du Pont Co., conducted the usual business meeting. He announced the result of the elections for directors of our section. The new directors are, Mr. Howard Amster, General Manager of Reliance Molded Plastics, Inc., Pawtucket, R. I., Glenn T. Tanner, Sales Engineer, Ralph B. Symons Associates, Inc., Tiverton, R. I., and Charles Chrones, foreman of Hassenfeld Bros., Inc., Central Falls, R. I.

The section is promoting quite an ambitious program scheduled for next fall. This program consists of a school or forum on a non-technical basis at the foreman level. It will consist of mold design, molding procedures, machinery, etc. The program will be absolutely free to all members, and is being handled by our Professional Activities Chairman, Mr. Howard Amster. He made a plea for anyone wishing to contribute ideas to the program, or who wished to volunteer as instructors for the various sessions, to contact him.

The door prize of the evening was donated by Miles Powell of E. I. du Pont, and was won by Mr. Bullard Pickering of Providence.

After the meeting, the section was addressed by two very fine speakers. Mr. Carl H. Whitlock, of C. H. Whitlock Associates, Detroit, Michigan, spoke on mold design as it relates to effective temperature control. He was followed by Mr. S. S. Zimmerman of The Vacuum Forming Corporation, who spoke on the new applications and future applications of vacuum forming.

Mr. Carl H. Whitlock pointed out that mold circulation systems had been used to considerable extent in the thermo-plastic field, and is now being considered, and used, in the thermo-setting field. The situations are just reversed, however, for in the former the problem is one of removal of heat from the mold, and in the latter the problem is the addition of heat to the mold. In either case, however, the key to the situation is correct and uniform transfer of heat. Since this heat must be transferred through both the plastic itself and the mold, the coefficient of heat transfer of both must be considered. Although there can be a great variation in the coefficient of heat transfer through the material from which the mold is made, usually all of these coefficients are quite high compared to the very low coefficient of heat transfer in the average plastic. Because of these differences, hot spots in the mold can develop, particularly on pieces which have heavy sections. If you add to this, badly placed water cooling channels in an injection mold, the temperature at various points in the mold can vary to such an extent as to make the mold unworkable.

Mr. Whitlock went on to point out that there is no such thing as a perfect mold, in this respect. He stated, "Sufficient channelling should be incorporated in the mold to obtain a transfer of heat at a controlled rate to give a uniform temperature on the surfaces of the cavities." The designer of molds should not worry about overdoing this point for it is impossible to have too many channels in a mold, if sufficient material is left for strength purposes. The normal practice of inserting 7/16" channels was not approved by Mr. Whitlock for he stated these were too small for most molds. A larger channel should be used and as many as possible for these inserted 1" apart throughout the mold.

It is commonly thought that the colder the water used to cool the mold, the faster the operating cycle. This is a common fallacy, however. If a mold is cooled at 45 degrees, the injected plastic will be chilled on the outer skin rather rapidly. If we then drop the piece into water, some time can be saved, but oftentimes distortion results immediately, or, at a later date, when the stresses tend to even themselves out. If, however, the mold temperature is kept at a point just below the heat distortion point of the plastic material, we can cool out that piece with no strain, and in almost the same time as with the cold mold. The latter case, however, has the advantage of permitting a lower injection cylinder temperature-in some cases 75 degrees. This means less heat in the plastic and less heat to remove in the mold. This can save considerable time in the cycle.

These two factors, correct channelling and correct temperature, are extremely important in mold design. Because of this importance, the placing of the channels in the mold should be considered from the outset of a new mold design

Mr. Sanford S. Zimmerman, of Vacuum Forming Corporation, pointed out that the vacuum forming part of the plastic industry has grown considerably in the last year or so. Because of the materials used in this business, it is oftentimes found that people compare the vacuum forming field with the injection molding field. Actually, the two are not competitive at all, for there are few pieces that could be handled practically by both methods.

When these two fields are brought into competition, it is found that injection molding offers a variable thickness wall, whereas, vacuum forming must be content with a uniform wall thickness. Injection molding, also, does not require the additional operation of trimming, which is found in the vacuum forming process. Vacuum forming, also, must use the expensive sheet-type materials. However, vacuum forming does have some advantages, for they can accept both short and long runs, because of their low tool cost. Although the wall thickness must be uniform, they can handle a much thicker piece than can be handled by injection methods. Also, vacuum forming can handle parts which require under-cuts and can handle parts which can be pre-decorated. These advantages open up many fields for the vacuum forming process and explains why this process is growing rapidly.

The field is growing so fast that it is estimated that by 1960, there will be 50 to 100 million pounds of material used in the vacuum forming process. It has also been estimated by some theorists that by 1965, this process may consume more tonnage of plastics than all of the others.

The materials which are being used in vacuum forming include acetate, some butyrate, polystyrene, acrylics, vinyls, and low pressure polyethylenes. Sheets of this material are produced by either extruding or calendering. The latter is more important where printing is involved, for it contains less strains than extruding the sheets.

Applications of vacuum forming process have been found in the following fields.

1. Decorative parts for displays and decorations.
2. The toy and novelty field.
3. Packaging. This field is probably growing fastest of all and applications are found for both platforms for any boxing system, and special plastic covers.
4. The appliance industry. We are probably all acquainted with the television mask, and the inner door panel for refrigerators.
5. The Aircraft industry. Old products in this industry include the radomes on aircraft and canopies on aircraft. New applications include the window trim, seat panels, and general interior trim.
6. The automotive trade. This field,

also, is growing very rapidly and by 1956 or 1957, there will probably be more vacuum-formed plastic parts on automobiles than any other plastic parts. These parts include seat trims, general trim, roof liners in station wagons, and hard top convertibles.

7. Industrial uses. Here we find plastic parts supplanting many parts formerly made of a metal, such as, tote boxes.

Mr. Zimmerman displayed many samples of these various applications of vacuum forming plastic. He concluded by pointing out that this newest of the plastic fields is not going to offer the competition to present existing plastic industries that it will to the stamped metal industry.

Toledo

Jones Discusses Vaccum Metallizing

D. E. Cordier

An exceptionally large turnout of 44 members and guests attended the October 19 meeting of the Toledo Section, Society of Plastics Engineers. An extensive and very well received program included a dinner at the Wellington Hotel in Napoleon, Ohio, an after dinner talk on "Vacuum Metallizing of Plastics" by Mr. Morgan Jones of the Red Spot Paint and Varnish Company followed by a plant tour of the Perfection Finishing Company of Napoleon, Ohio to view their vacuum metallizing operations.

The speaker explained in considerable detail the physical factors involved in vacuum metallizing including a discussion of the theoretical aspects of the molecular activity which exists during the low-vacuum phase of the metallizing cycle. Also described were the mechanical and diffusion types of vacuum pumps which are used to produce the very high degree of vacuum necessary for vacuum metallizing operations. The complete sequence of operations as they occur in a metallizing cycle were described by the speaker.

Considerable emphasis was placed on the important role of protective finishes and coatings in this type of metallizing process, and the requirements of the resin base coat and top coat were reviewed. The speaker discussed many of the common problems such as frosting, cratering, poor adhesion and poor mar resistance which may develop from an improper choice of coatings or from their being improperly applied.

Following the talk and discussion period the group adjourned for a most interesting trip through the Perfection Finishing Company where a complete vacuum metallizing process was viewed.

Membership Competition Chart

Section	Membership Chairman	Members July	Members Oct.	Quota To Go	Quota Met
Baltimore-Washington	Bernard E. Franklin	84	91	17	35%
Buffalo	Ranson D. Thilk	76	77	15	13%
Central Indiana	C. R. Smith	46	54	15	100%
Central Ohio	William Croll	50	50	15	13%
Chicago	E. E. Eckenbeck	354	373	71	20%
Cleveland-Akron	Granville H. Shirley	219	233	45	22%
Connecticut	Lewis Pentland	102	110	21	10%
Detroit	John Slater	201	216	40	25%
Eastern New England	Joseph Clancy	163	176	35	20%
Golden Gate	James Smith	42	46	10	10%
Kansas City	Jerome Kivett	52	52	15	13%
Kentuckiana	J. Feller	4	24		
Miami Valley	R. Wright	99	105	21	5%
Milwaukee	Charles E. Egan	42	43	10	0%
Newark	Frank L. Quimby, Jr.	428	442	85	15%
New York	Arthur S. Jacobs	443	474	92	13%
Northern Indiana	Phil Leonard	23	23	10	10%
Northwest Pennsylvania	D. A. Leet	86	88	20	20%
Ontario	G. Rea	122	122	21	0%
Pacific Northwest	Don LeGassey	32	33	10	0%
Philadelphia	Edward Fitzpatrick	230	249	47	21%
Pittsburgh	Charles G. Snyder	61	61	15	27%
Quebec	J. Bonnett	52	52	10	0%
Rhode Island & SE Mass.	Sidney Lohman	107	109	22	0%
Rochester	Albert F. Patterson	83	87	20	5%
St. Louis	Chris Kacalieff	73	76	15	13%
Southeastern Ohio	Paul M. Smith	43	43	10	0%
Southern California	R. Griffith	138	150	28	36%
Southern Section	R. W. Kruse	60	62	15	27%
South Texas	T. Robb	41	41	10	0%
Toledo	W. R. Anderson	66	70	15	7%
Upper Midwest	Mrs. L. Bolstad Orville Hultgren	69	75	15	47%
Western New England	W. G. Clark	202	202	40	15%
Worcester-Leominster			4		
Non Section		58	69		
TOTALS		3951	4182	830	19%

Southern California

Membership Totals 191; Group Expects To Hit 200 This Month

Felix C. Karas

The November meeting of the SPE took place on November 3rd at Scully's Restaurant. Mr. Walter Cadlec, Chairman of The Southern California Chapter announced that the number of members has risen to 191 and that there is justified hope that before the end of the year the 200 mark will be reached.

After the introduction of the panel of the nominees for the 1956 Directors, the meeting was turned over to the Program Chairman, Mr. Bill DeWar, who introduced the speaker of the evening Mr. W. H. Jones of the U. S. Testing Laboratories.

Mr. Jones' topic was "Plastic Testing." He explained that the plastics engineer is faced with the problem of coordinating, and interpreting the mass of data defining his materials. The data results from the efforts of people in widely diverse technical disciplines; from optics to chemistry, from heat effects to bacteriology. Standard methods of test are the integrating means allowing the engineer to determine appropriateness of method to his use application. Short comings in the methods available do not allow for complete prediction and engineering design. Major shortcomings are in the arbitrariness of method —size and shape of sample, rate of load applications for tensile strength determinations, etc., and the lack of any true physical constants such as are available for other materials. Unfortunately, at this date, the test methods used to define plastics are based upon, or derived from, methods used to define other materials. Actually, plastics are a material distinct from all others, and their ultimate definition for application purposes will come only when test methods are established with this distinction in mind.

A lively question and answer period lasting well over 30 minutes followed the speech.

St. Louis

Ceramics Society Meets With Group

R. S. McDorman

The October meeting of the St. Louis Section of The Society of Plastics Engineers was held jointly with the Ceramics Society of St. Louis at the Engineers Club.

The speaker was Mr. Conrad Claeson, Application Engineer and Director of Field Training, Wheelco Instrument Co., Division of Barber-Coleman Co., Rockford, Illinois.

Mr. Claeson spoke on Simplified Proportioning Heat Control. He described control instruments from the basic off-on to those using full proportion control.

Baltimore-Wash.

Polyurethanes Are Discussed

McCarthy, Seymour Speak To Section

William C. Rainer

The November 8th meeting took place in the banquet room of the Langley Park Hot Shoppe, at Takoma Park, Maryland. Dinner was served at 7:30 P.M. Fifty-six members and guests were present. Section President, Dan Nitzberg, called the meeting to order at 8:30 P.M. He directed the group's attention to the coming election by presenting in advance the nominating slate for Section Directors for the new year. All nominees were requested to take their respective bows. After the short business preliminary, the speakers of the evening were introduced, viz: William J. McCarthy of B. F. Goodrich Chemical Co., and Albert Seymour of B. F. Goodrich Sponge Products Division. Their respective topics were: "Chemistry of the Polyurethanes" and "Flexible Polyurethane Foams." The following resume spells out the high lights of the combined talks:

The chemistry of the polyurethanes involves a reaction between polyisocyantes, e.g. meta-toluene diisocyanate, and active hydrogen bearing substances, e.g. hydroxyl-, amino-, oxime-, and peptide-groups. Dihydric alcohols, diamines and alkylol amines are commonly used today.

Diversification is one of many assets of the polyurethanes. They can be crosslinked with natural and synthetic elastomers to form adhesives, coatings, etc. Foamed polyurethanes are of particular interest. The foaming is brought about by reacting an isocyanate compound with water, thereby forming carbon dioxide gas and developing polyurea linkages. Upon further reaction with excess isocyanate, the resin becomes cured. During the process the entrapped gas expands the whole into a cell-like structure.

Economic evaluation of polyurethane foam leaves much to be desired when compared with rubber and vinyl foamed products on an equal basis. It is approximately equivalent dollar-wise; however, in a 1:2 weight ratio per unit volume whenever the end use of the product warrants such composition, Polyurethane foams are finding application as cushions and carpet underlays.

The meeting was concluded at 10:30 P.M. Our thanks to the speakers for their time and energies devoted towards making this evening a success.

Philadelphia

'Plastics For Industrial Engineering' Is Topic Of Joint Monthly Meeting

C. H. Jetson

"Plastics for Industrial Engineering Applications" was the topic of discussion at the regular joint SPE-SPI monthly meeting on November 22, 1955. Mr. W. C. Wall of the Polychemicals Department of the du Pont Company described how and why the use of plastics in industrial applications has grown so rapidly in recent years. Mr. Wall's background in mechanical engineering, coupled with his experience in industrial consulting with the du Pont Co., brought this expanding field of application for plastics into clear focus.

Generalizations are difficult to make in so broad an area, according to Mr. Wall, but it certainly holds true that good design in plastics must stem from an intimate and complete knowledge of the properties of the material you wish to use. The designer must think first of the primary property requirements, but he must remember that failure can occur from neglect to design for all possible requirements of service. Mr. Wall offered examples of the kind of thinking that all good designers must practice, using as illustrations successful and (in some cases) unsuccessful designs in "Alathon" polyethylene resin, "Lucite" acrylic resin, "Teflon" polytetrafluoroethylene resin, and "Zytel" nylon resin. The designer of an oil seal may want to take advantage of the low coefficient of friction of tetrafluoroethylene resin to reduce power losses for example. He cannot simply duplicate a seal from another material such as rubber because the recovery, modulus, and frictional properties are all different, and a wholly new design is needed. Mr. Wall showed numerous examples of successful design in oil seals, bearings, gears, wire coatings, electrical parts, decorative parts, and many special purpose devices difficult to classify. Over forty color slides illustrating these applications were shown during the meeting, and samples of almost all of the parts discussed filled a twenty foot table for inspection by the audience. Following the formal meeting a number of the members discussed specific examples of good and bad part design with Mr. Wall and his associates until the late hour made it necessary to vacate the Institute.

New members welcomed to the Philadelphia Chapter of SPE included Mr. James B. Sheffer, Jr., Mr. Jay H. Rosenson, Mr. Paul E. Thomas, Mr. William J. Davis, and Mrs. McKay Collette. The Section President, Ed Derowski, invited all members and guests to the Ladies Night meeting on December 14. This is to be a social hour followed by dinner, and dancing to midnight in Franklin Hall of Franklin Institute. Members please note that this coming meeting is an exception to the usual meeting date of the fourth Tuesday of each month.

Central Indiana

Membership Goal Almost Reached

C. R. Smith

As the Central Indiana Section gathered for its monthly meeting at the Warren Hotel in Indianapolis on Nov. 29th, it stood just two short of the additional members goal requested by National Chairman Fred Sutro, Jr. in his nation wide appeal of Sept. 20th.

Additional raffle tickets were awarded to sponsors of the most recent applicants, in accordance with the terms of a Membership Contest started last September. These tickets may win for the lucky holder, one of three attractive prizes in a drawing to be held next month during the regular Section meeting. Mike Ebbert collected for four new members, and I understand he hasn't quit yet. That proves it can be done, so lets everyone get in the race.

Guests and members enjoyed tremendously the much heralded discussion of Super Dylan polyethelene, presented by Mr. V. O. Reising, Technical Coordinator of Plastic Market Development for the Koppers Company. The popularity of this talk is attested to by the frequency with which it has appeared in the various Sectior. News Reports—to which little can be added, other than the recommendation that more Program Chairman avail themselves of this most enlightening presentation. I'm sure many of our Section members placed a higher value on their Society Membership after attending this evenings program, realizing that here had been the opportunity to get a first hand, technical and intelligent report on the properties of a new material that undoubtedly broadens the scope of potential applications of the Plastics Industry as a whole.

Detroit

Don Skoog Wins McDonald Cup At Golf Party

Mac Nichols

The Detroit Section held their 1955 Fall Golf Party at the St. Clair Inn and St. Clair Country Club on Friday and Saturday, September 23 and 24.

The event was attended by approximately ninety members and guests who spent the two days in relaxation on the links and at the Inn.

The golfers who braved the elements in competition for the Stuart MacDonald Silver Cup, emblematic of the Section Championship, were impressed with the cleverly trapped yet well groomed course and "par" was often talked about, but never seen.

Don Skoog of Dupont carried home the trophy, which will be put back into circulation at the subsequent golf tournaments scheduled for next year.

If the proposed arrangements mature, the 1955 Christmas Party promises to be one of the most elaborate and successful parties ever to be given by the Detroit Section.

Under the able direction of Mike Herzina, this event, scheduled for Friday, December 16th will be held at the Sheraton Cadillac Hotel and has been planned to include the wives of the members and guests.

The program will consist of a delightful dinner, followed by dancing, entertainment and prizes.

Frank Giordano, the Detroit Kepresentative of the Catalin Corporation, advises that his firm has recently opened a new warehouse on Brandt Street in Dearborn. Mr. Giordano states that the additional thirty thousand square feet of floor space will enable them to stock more material to expedite deliveries to their many customers in this area. Catalin is now producing polyethylene as well as a full line of compression molding compounds.

Manco Products has recently installed a new 400 ton hydraulic press to further keep pace with the growing demands for their Beryllium Copper castings. New presses have been added to the molding equipment at the Blue Water Plastics Co. in St. Clair and at Continental Plastics on Dequindre Road in Detroit, while Mold-a-Matic Inc., have just completed a new addition to their plant.

We regret to report that a flash fire completely gutted the plant of the Molded Products Corporation, but Dave Clemenson picked up the salvagable pieces and is back on a limited production schedule in a temporary location while his plant is being rebuilt. We doff our hats to Dave's courageous tenacity!

Cleveland

Haskins Wins Product Award; Moyer Speaks On Materials

Bob Hershey

On Monday, November 14th, 1955, 95 members of the Cleveland Chapter of SPE gathered at The Spanish Tavern, Brecksville, Ohio, to hear Mr. Robert L. Moyer, Technical Service Engineer of Monsanto Chemical Co., Plastic Division. Bob Moyer, formerly associated with Chicago Molded Products and Continental Can Co., Plastic Division, came from Springfield, Mass. to give us one of two best technical discussions of the basic nature of our molding materials this reporter has ever heard. Using simple terms, Mr. Moyer described the various types of molding powders in common use, showing how they are built up, and how their fundamental nature finally affects their use as molded articles.

By helping us grasp the behavior of the various molecular structures we are dealing with, he helped us understand the reactions of the materials to molding conditions. Greater uniformity of softening point has assisted in greatly improving moldability of newer styrenes, because new process controls have minimized the percentage of higher molecular weights to give better flow properties. He pointed out how tailoring of the molecular weights of styrene has greatly broadened the market potential for the molder, and made the selection of the right plastic more important than ever. The structure of styrenes, Mr. Moyer said, does not accept lubricants very well, and we have to rely humanly on the material people who are working with the basic nature of the material for good moldability. This fact did not, however, prevent one molder from using discarded hydraulic oil to lubricate a hard-to-mold styrene! But Bob recommended high melting point waxes like zinc stearate or Acrawax C for better results. In styrenes, the lubricants tend to separate and can form objectionable welds, he pointed out, especially if used unwisely or to excess.

Lubricants do not soften styrenes, but merely minimize friction. Once the material is melted they can burn or char. He indicated that more serious evaluation of their role in the injection industry is vitally needed, and that a few studies are now being undertaken on lubricants for the first time.

New methods of grading crystal styrenes are needed as at least 27 grades exist. Heat distortion is one measure, and molecular weight is another. If the material sets up too fast in the mold it may lack inherent flow properties, and in cases like this, the molder can do little about his molding problems in the field, but must rely on the material people to produce a moldable compound, that will meet the end users requirements. Only by evaluating and correctly applying the wide range of styrene types now available can the molder hope to broaden his markets.

Mr. Moyer's talk was a fairly technical one, and yet one that helped everyone who heard it to better understand the fundamental nature of the powders we work with every day—and sometimes to take too much for granted!

Reports were heard from Ed Campi about our Christmas Party at The Chesterfield Inn in Cuyahoga Falls, Ohio, scheduled for December 9th and from Frank Martin, General Chairman of the 1956 SPE Annual Technical Conference, who reported everything well in hand.

A surprise feature of the evening was the Injection Molders Supply Co., Annual Product Award, made to Ed Haskins of Zenith Plastics in Cleveland for his "Nozzle Seat Lapper," designed to greatly improve nozzle and heater seat life. Mr. Haskins received a check for $100 and a royalty arrangement covering his new Lapper which is made and distributed exclusively by IMS.

The award is made annually for the best idea for a new product, or for the most improvement in an existing one. In making the award, Red Morse, of IMS, stressed the fact that virtually all his products derived from . . . **ideas**, and the annual award symbolizes his company's obligations to the many fine engineers in the injection molding industry.

Abstracts from Revista Brasileira which appeared in the October 1955 SPE Journal were credited wrongly. The abstracter for this magazine is Louis A. Helwich.

Milwaukee

Paul West, Carl Whitlock Talk On Mold Temperature Control

Marvin C. Stowe

The Milwaukee Section of the Society of Plastic Engineers had a dinner meeting on November 8, 1955. After a delicious dinner a brief business meeting was held. An announcement was made that the Milwaukee Section is planning a Christmas party this year. It was also mentioned that the results of this year's election will be announced at our December meeting.

Upon conclusion of the business meeting Mr. John Verburg, our President, introduced our speakers for the evening. They were Mr. Paul West of Sterling, Inc., Milwaukee, Wisconsin and Mr. Carl Whitlock of C. H. Whitlock Associates, Detroit, Michigan. They gave a joint talk on equipment methods and mold design for mold temperature control. Mr. Paul West talked to us first and his main subject was equipment for mold temperature control. Mr. West brought out that the proper equipment is very important in attaining mold temperature control. For instance, equipment that has simplicity in handling and operating, also the capacity and the capability of the equipment in respect to the speed it can change or regulate the temperature, etc.

Mr. Whitlock then discussed the part that mold design plays in mold temperature control. It is surprising how important mold design is. For instance, the design of the mold has a great deal to do with the distortion of a piece. The entire distortion problem is not based on the mold design, however a greater percentage of it is. The lack of uniform heating and cooling of the mold is generally the cause for distortion of the piece. A couple of points that were brought out at this time regarding the consistency of the temperature throughout the mold are that the faster the temperature controlling liquid goes through the mold the better chance there is for uniform molding temperature. One reason would be the faster the liquid goes through the mold the smaller temperature difference there will be in the liquid from the time it goes into the mold compared to the time it leaves the mold. A change of three degrees in the temperature controlling liquid as it passes through the mold is considered large. Another point that was brought out was that the cooling and heating channels should be large enough. It is seldom that it is possible to get these channels too large.

The problem is not so difficult in designing a good mold but in realizing the importance of such things as heating and cooling channels. As Mr. Whitlock brought out, the procedure in designing a mold generally starts out with the placement of the cavities and punches in the die set and after the entire mold is designed the heating of cooling channels are then given some consideration.

It seems in many cases that if these channels do not interfere with the rest of the mold they are properly located. This lack of consideration for these channels is practically evading the entire purpose for such channels. The important thing that should be considered is the uniformity of the temperature throughout the mold. Proper placement of these channels has a lot to do with giving you this uniformity. If there are hot or cold spots in the mold chances for stresses and distortion are very, very good. Another contributing factor in attaining good pieces is the relationship of the mold temperature to the material temperature. This is particularly important in the case of injection molding. For example, in operating a mold where the differential in temperature of the mold and the material is smaller the piece attains its ejection temperature sooner permitting less distortion. Besides the perfection of the piece, the cycle is also shortened by this method.

These are a few of the important high points that were brought out in respect to mold temperature control. In conclusion the subject was very well covered by our speakers. A lot of questions were answered for the individuals after the close of the meeting. All of the 75 members and guests that attended were very well satisfied.

Detroit

Section Sees Ford Research Division

Mac Nichols

The Detroit Chapter of the Society of Plastics Engineers was accorded an honor extended to very few groups, when on November 14th, a comprehensive tour of the Engineering Laboratories and Research Division of the Ford Motor Company, was made available.

Approximately 110 members and guests met at the Dearborn Inn at 4 P.M. and were transported in buses furnished by the host company to the Laboratories where they were met by a group of the Ford Engineering staff.

The tour consisted of a detailed study of the Standards Department of the Plastics Division where parts fabricated from thermoplastic and thermosetting materials were being checked in the laboratories for resistance to heat, cold, impact, wearing qualities, abrasion and corrosion. A portion of the trip was arranged to include an exodus into the famed and mysterious "testing tunnel" underneath the laboratories. There, a brief discourse was presented covering the Principles of Optical Design, Photometric Requirements for Lens and Reflex Reflectors, and Methods of Reflector Testing. Identical plastic lens were subjected to the most rigid tests and the group was given the opportunity of discerning the flaws in apparently sound molded parts.

Following an excellent dinner at the Inn, Richard Brewer, James Oldham and Milton Jumisco of the Ford Engineering Staff served as a panel for further discussion and questions on the "Application of Plastics in the Automotive Program" with Jack Totten acting as Moderator.

Edwin Bertsche

Mr. Edwin Bertsche's death was quite a shock to his friends, as he had been in good health up to 3 days prior to his death, which was caused by a heart condition.

Ed was born in Switzerland in 1887 and came to the United States in 1915. He worked in the Connecticut area as a tool and gage maker. In 1918 he went to Dayton, Ohio and found employment as a mold maker, which trade he followed to the date of his death. In 1922 he returned to Connecticut and was employed by Johns-Pratt. In 1924 he went to work for Arrow-Hart & Hegeman as a hobber. In 1926 he entered employment for the Colt's Mfg. Co. as a foreman in the mold tool room. In 1939 he left Colt's Mfg. Co. to go to the Parker Stamp Works as superintendent of mold work. In 1944 a partnership was formed between Ed, Helmar G. Anderson and Clarence T. Anderson known as the ABA Tool & Engineering Co. This company was later incorporated as the ABA Tool & Die Co. Inc. and Ed became Vice-President of the concern which position he held until the date of his death.

Ed was widely known in the moldmaking field.

SPE Conference

LADIES PROGRAM

Wednesday, January 18, 1956

9:30 a.m. — "Get Acquainted" Coffee Hour—Statler

12:15 p.m. — Luncheon—Halle's Tea Room

2:20 p.m. — Playhouse Matinee and backstage reception — "The Solid Gold Cadillac"

Thursday, January 19, 1956

9:30 a.m. — "Brunch" — Radio Show over Station WERE, from Halle's Tea Room. Audience participation, entertainment and door prizes.

1:00 p.m. — Luncheon and Fashion Show at Higbee's

6:00 p.m.—Cocktail Party—Statler

7:00 p.m.—Banquet

Friday, January 20, 1956

9:00 a.m. — Coffee Hour — Statler

10:30 a.m. — Trip to Nela Park Home Lighting Center

Transportation will be furnished where required for Ladies' Events.

SPEaking of Extrusion

(Continued from page 43)

available. And, of course, it is possible to fabricate one from materials at hand. In any case, the probe must be stiff enough so it is not bent out of position by the force of the viscous plastic pushing by it. The junction should be located approximately in the center of the channel, where the largest movement of melt occurs. It may be necessary to bend the probe so that it runs downstream a short distance before terminating.

The probe should enter the flow channel in such a position that any weld line created will not be noticed. Some materials will show a weld line for a surprisingly long time after the stock has passed by the probe. In sheet extrusion, for example, the probe should enter the flow channel horizontally so that the weld line, if any, will occur on the edge of the sheet.

To summarize: Vastly superior control over the extrusion operation can be obtained if, instead of the commonly used method, temperature is measured as the melt enters the die, and the die temperature is measured internally. This technique makes it possible to decide what adjustment is needed when the operation goes off for any reason, and to bring it back exactly where it was. It enables the operator to start up after a period of shutdown and duplicate previous results quickly. It is also of great value when a job has to be moved from one extruder to another. In short, these two temperature measurements are the key to precision operation.

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First SPE Regional Conference Covers "Plastics for Packaging"

Jim Dugan

"Plastics for Packaging" was the theme of the Atlantic Regional Conference, which was held November 16, at the Hotel Statler in New York City. Sponsored by SPE's New York Section, the meeting included an all-day technical symposium which was attended by 178 members and 120 guests. Fourteen states were represented, and three foreign countries. Lunch and dinner were served, and educational exhibits were on display.

Anthony Dragonette, Bakelite Co., opened the morning session with a talk on "Vinyl Plastic Packaging;" discussing applications, processes, advantages, and potential markets for calendered and cast vinyls. He covered the field of vacuum formed packages and containers, which include unplasticized, flexible, and semi-rigid films. Of particular interest is the skin type package, where the film covers and protects the product while securing it firmly to a cardboard base. Preheated films are forced around the item by atmospheric pressure after a vacuum is drawn, variations of which include the recess pack and the bubble pack.

"Cellulose Acetate's Role in Packaging" was the topic of an address by Robert B. Carter, Celanese Corp. of America. Thin gage (0.5-2 mil) cast and extruded film is used for plain and printed wraps, transparent bags and envelopes, window bags, and window boxes. It can be used in combination with other materials by lamination to kraft paper, cardboard, metal foil, fabric, and saran to obtain a balance of properties. Other forms used in packaging include cast and extruded sheeting, molded containers, and extruded tubes.

E. V. Hellyar, Monsanto Chemical Co., spoke on "The Role of Styrene in Rigid Packaging;" where clarity, dimensional stability, and light weight are combined with low cost. Colors are possible, as well as transparent, translucent, and opaque effects. Some of the most attractive, "throw-away" packings are made of styrene which has reached a volume of millions per year. Molded, rigid dispenser packs and vials have replaced glass in numerous applications.

Spencer Chemical Co.'s Mark Stringfellow spoke on "Polyethylene from Here to '60" reviewing estimated capacity, production, and consumption as well as prophesying areas of future growth. Four primary reasons for the material's ever increasing use in the packaging field are: faster selling by personal selection; reduced losses from soilage; increased floor space; and increased unit sales. Numerous figures, available from the U. S. Department of Agriculture, were shown by the use of slides.

T. H. Derby, Sylvania Division, American Viscose Corp., spoke on "The Versatility of Cellophane," which combines sales appeal with protective qualities. Introduced 40 years ago as a luxury packing, cellophane has been reduced in cost to the point of becoming the workhorse of the transparent packaging industry. The material can be produced in varying degrees of moisture-proofness, and is regularly impervious to dry gases. It can be heat-sealed, or joined by adhesives, and is adaptable to automation. Other machineable properties include uniformity of gage, good tensile strength, rapid heat-seal, and freedom from static electricity.

"Mylar Polyester Film for Packaging" was covered by J. L. Jenemann, E. I. du Pont de Nemours & Co. The interesting feature here is the balance of properties rather than dramatic appearance. Where visibility is demanded, Mylar offers crystal clear transparency; yet it has been widely used in metallized form for the trim on autos. Moisture-proof properties are similar to comparable gages of polyethylene.

"Expandable Polystyrene," as shown by E. A. Edberg, Koppers Co., is capable of producing an endless variety of shapes and forms. Extruded foams, colored by dry-blending, offer useful properties in three fields of packaging. They can be used by the military to cushion precision parts in transit. They can be used both as a tote box, and as a vehicle in which to suspend delicate parts. "L" and "U" shaped sections protect edges and corners of furniture and glass. Lastly they offer eye-appeal through freedom of design.

"Visqueen Polyethylene" was discussed by James F. Bernard of Visking Corp., who brought out the following reasons for the material's acceptance by the packaging industry: economy, toughness, excellent aging properties, non-toxicity, chemical resistance, unique gas transmission properties, low temperature flexibility, light weight, printability, ease of fabrication, and eye appeal. It is also reported to be the least expensive of the transparent packaging materials.

"Plastiatrics of Rigid Molded Packages" was the topic offered by E. L. Kropscott, Dow Chemical Co. With respect to the injection molding of packaging materials, the following developments were said to have played a dominant role in their acceptance: mold temperature control, restricted and balanced gating, controlled plastic flow, preplasticizing, and weighed feeding. The three steps required for the successful molding of a rigid plastic package were presented: rapid mold filling at correct temperature;

W. D. Lahey, B. F. Goodrich Chemical Co. spoke on the use of vinyls in packaging, covering the following applications and processes: lid sealers, sponge cushioning, coated glass containers, vacuum formed boxes, dipped goods, blow molding, rotational casting, slush molding, and packaging tapes. Lloyd Stouffer, editor of Modern Packaging, spoke on "The Future of Plastics in Packaging," covering the past history and the expected futures of each material. The outlook is reportedly excellent, due to plastics' low cost, big volume production, practability, and expendability. This is particularly significant in the light of plastic's recent entry into the packaging field (just ten years ago this month).

Plastic packaging is still in its infancy, according to Egmont Arens, designer and consultant. Plastics now provide low-cost solutions to many types of packaging problems, while resembling luxury items. Good design is indispensable for upgrading the industry, and plastics offer a designer's delight through their unique properties and three dimensional forms.

Central Ohio

Tour of EBCO Plant Is Made

Victor Hauprich

The regular monthly S.P.E. Meeting was held November 15 at Meadowbrook Inn in Columbus. A chicken dinner was served at 7:00 p.m. Since the feature of the meeting was our tour of the Ebco Plant, which took nearly two hours, only a very short business meeting was held.

The seven guides from Ebco were introduced and the entire group left the Ebco Plant. The plant is one of the most modern in the country, and our tour was very interesting and well handled by the Ebco men. The various groups, after seeing the entire plant, broke up around 10:00 p.m.

Northwest Penn.

Edward A. Zacks

The Northwest Pennsylvania section met October 27th at the Beachcomber Hotel in Erie, Pennsylvania to hear Lloyd Parks of Logo, Inc., speak on plastic coatings. The talk was illustrated with slides.

Kentuckiana

New Section Reports Activities

K. A. Erwin

The November meeting held on the 16th was in Evansville, Indiana. The dinner which preceded the meeting was served at Kokie's and was attended by 33 members and guests.

Following the introductory remarks of the various officers the guest speaker, Mr. G. W. Borkland was introduced. His subject of vacuum forming covered its history, the need for trained personnel, uniformity of sheet, controls required, equipment versatility, etc. and was highlighted with various samples submitted to the members for examination.

October

October 26 noted the second meeting of the Kentuckiana Section with 38 people present. The meeting was preceded with a dinner held in one of the cafeterias at the General Electric Company's new production facilities at Appliance Park, Kentucky.

After the opening remarks by the Section President, the Program Chairman introduced the guest speaker, Mr. Ernest P. Moslo, President of Moslo Machinery Co. and Vice President of the National S.P.E. Mr. Moslo gave a very enlightening talk on automatic molding. His talk was followed by a tour of the General Electric Refrigerator Department's injection molding and vacuum forming section. The members and guests noted that this section was composed of thirty injection molding machines and seven extruders with numerous vacuum forming machines and associated equipment of novel design.

First Meeting

The first official meeting of the Kentuckiana Section was held in Evansville, Indiana on September 21, 1955 at Smitty's Steak and Sea Food House with 36 persons in attendance. A dinner preceded the meeting.

The meeting was opened by A. M. Varner, President, who welcomed the group an introduced the officers and Board of Directors. Bob Millar, the Program Chairman, had each member and guest rise, introduce himself, and give his company affiliation.

Our Section was honored by the presence of Mr. Frank W. Reinhart who was the guest speaker. Mr. Reinhart reviewed the activities of the National S.P.E. whose objectives he stated were Service, Progress and Education. His second topic pertained to the activities of the Plastics Section of the National Bureau of Standards. A great deal of interest was indicated by the many questions which Mr. Reinhart very ably answered.

Southern

Visit Scripto Plant

C. Veazey LeCraw

The Southern Section had two very interesting meetings in October and November. For the October meeting Southern Section President Clarence E. Ballentine, of Scripto, Inc., acted as our host for a plant tour of the injection molding facilities at Scripto's plant in Atlanta. This company has the largest injection molding operation in the south and offered an interesting view of high production molding techniques. It was plain to see after this trip how Scripto can offer their complete line of mechanical pencils, ball points, and fountain pens at such reasonable prices in a highly competitive field. The answer was plainly—mass production.

For the November meeting, the Section was fortunate to have Mr. Clarence White, of Eastman Chemical Products, present a program on "Cellulosics in Molding and Extrusion." Mr. White outlined the outstanding properties and limitations of the four cellulose plastics — (1) cellulose nitrate, (2) cellulose acetate, (3) cellulose acetate butyrate, and (4) ethyl cellulose. He emphasized the importance of close cooperation between the material supplier, the molder, and the end user in order to obtain a good product, with the greatest responsibility perhaps falling on the molder. He enumerated the precautions which must be taken by the molder in order for the end product to have the properties which are advertised by the raw material supplier. Some of these are (1) dry molding material, (2) optimum cylinder temperature, (3) controlled feed rate, (4) high injection pressure, and (5) good mold design. An excellent color film, "The Story of Tenite," was presented following the talk. A question-and-answer period following the film was found to be most helpful from the standpoint of helping the members realize fully all of the outstanding features of this interesting group of plastics.

The Section Secretary, Bradford L. Nicholson, who is also a very excellent Program Chairman, made a report on the annual "Ladies Night" program planned for December. The program includes a dinner-dance complete with one of the local radio disc-jockeys serving as Master of Ceremonies. A good time is expected by all.

The nominating committee submitted a slate of nominations for the three new members of the Board of Directors to take office on January 1.

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Prehardened Mold Steels

(Continued from page 38)

The data obtained are plotted in Figure 4 which shows the Brinell hardness in relation to the depth below the surface of the bar. It is evident that the hardness of the precipitation hardening steel is 331-341 Brinell throughout the entire bar section, whereas the hardness of the AISI 4130 type steel gradually drops from 302 at the bar surface to 197 at the center of the bar. The importance of this property, of course, is in the fact that when deep cavities are machined into a block of prehardened steel the hardness at the bottom of the cavity must not be low, otherwise the strength of the steel in that locality may not be adequate.

This brings us to item five where we stated that the steel must have adequate strength and toughness and a good balance between these two properties. The strength of any steel is roughly proportional to its hardness; as a matter of fact, the tensile strength of the steel in thousands of pounds per square inch is approximately one-half of the Brinell hardness number. For example, a steel with a Brinell hardness of 300 has a tensile strength roughly of 150,000 psi. Now in using a prehardened type of steel for a mold, the hardness is limited by the fact that the steel must be machinable. This generally limits the hardness to somewhere around 300-360 Brinell, or 31-38 Rockwell C. Fortunately, this hardness range gives sufficient strength to the average mold to perform satisfactorily. It is about the same hardness as obtained in the core of an alloyed carburizing grade of mold steel and it is considerably higher than the core of a carburized hobbing steel after heat treatment.

Figure 5

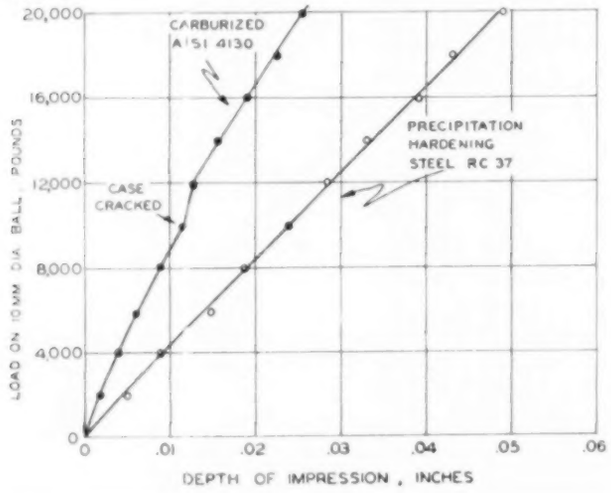
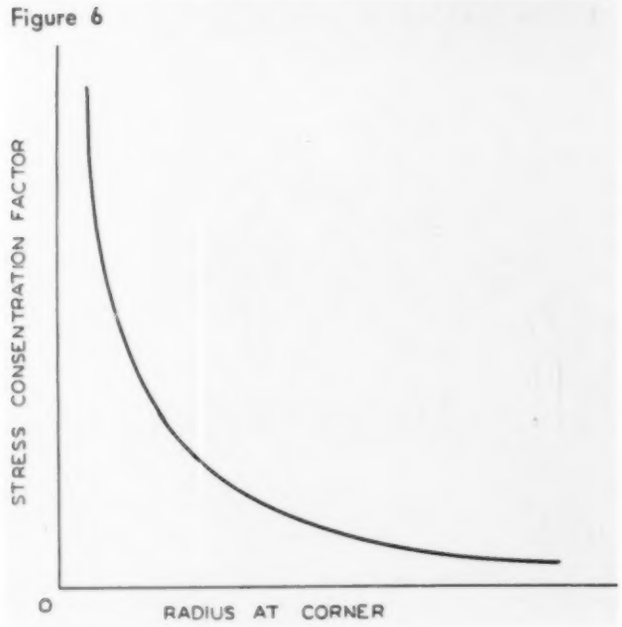


Figure 6



The strength of the steel in a mold controls several important factors. For example, it determines whether or not the mold will deflect or bend excessively under operating load, and whether thin sections of the mold will deform under load and go out of shape. It also determines the resistance of the steel to denting, and this is a very important property from the standpoint of the plastic mold user. The compressive strength of the steel, like the tensile strength, is also proportional to the hardness. However, it is not a simple matter to predict under what conditions and at what hardness level a steel will resist denting. The problem here is primarily one of denting or peening from flash between the cavity and force of the mold. The compressive stresses encountered under such conditions cannot be calculated with any degree of accuracy but are known to reach extremely high values under certain conditions. Probably the only way that the factor of resistance to denting can be accurately evaluated is by experience, and experience has shown that the prehardened steels stand up surprisingly well in this regard under actual operating conditions. A good analogy is the use of beryllium copper for hobbed cavities. In use, it has about the same hardness as a prehardened mold steel, and the success of beryllium copper as a mold material is well known to most of those in the plastics molding industry.

With a carburized steel the resistance to denting under compressive load will depend on such factors as the case hardness, the case depth, and the underlying core hardness. Merely having a high surface hardness does not insure resistance to denting. In an effort to obtain some comparison of resistance to denting of a carburized alloy steel and the precipitation hardening prehardened steel, representative samples of these two materials were dented with a tungsten carbide Brinell ball at a series of loads. The results are plotted in Figure 5, showing the depth of the ball impression as a function of the compressive load applied to the ball. The case hardened 4130 steel, having a much higher surface hardness (Rockwell C 59) naturally has dented less than the precipitation hardening steel. However, it is of interest to note that both steels show measurable amounts of denting even at relatively low loads, and the case on the carburized steel cracks at an applied load of 10,000 pounds. This cracking is the result of the hard brittle case deforming into the relatively soft core material lying beneath. Case depth in this instance was .035", and core hardness Rockwell C 34.

While on the subject of strength and surface hardness, it should be pointed out that although the prehardened steels are generally used in their original prehardened condition it is possible to increase the surface hardness after machining and polishing by a heavy chromium plating or a nitriding operation. This is occasionally found to be desirable for special applications where resistance to surface damage from scratching, wear or corrosion is particularly critical and the added cost of the surface treatment can be justified. In this con-

nection the precipitation hardening steel lends itself especially well to gas nitriding as a means of increasing surface strength and hardness, because of the aluminum content (which forms aluminum nitride) and the fact that the nitriding treatment is carried out in the same temperature range as the aging cycle. A gas nitriding treatment of 20 hours at 950°F will produce a case approximately .006" deep having a hardness of about 68 Rockwell C, with no reduction of core hardness and no appreciable distortion of the finish machined mold. It should be kept in mind, however, that the nitriding must be carefully performed by an experienced heat treater to be successful, and like all case hardening treatments it cannot be applied without an appreciable sacrifice in toughness.

Toughness of a steel, or notch sensitivity as it is sometimes called, is generally thought of as being more or less inversely proportional to hardness. That is, we gain hardness at the sacrifice of ductility. However, toughness is a property which depends not only on the metallurgy of the steel but also on the design of the mold. Any steel, no matter how ductile, can be made to fail in a completely brittle manner if the stress concentration is sufficiently high. At corners of mold cavities and at other sharp changes in section the concentration of stress under operating load can become extremely high. It is probably safe to say that at the hardness level of the prehardened mold steels all of the available steels have plenty of ductility in the absence of sharp notches, but if a corner in a mold does not have sufficient radius, danger of sudden brittle failure in operation is present regardless of the steel used or its hardness. Too many times we are asked to examine a broken mold for evidence of metallurgical defects only to find that the failure was caused by a sharp corner which should have been avoided in the design of the mold.

All good mold designers realize the importance of avoiding sharp corners, but I wonder how many fully understand the magnitude of the reduction in stress concentration that can be accomplished with a very small increase in radius at a corner. The general relationship of these two design functions is shown in Figure 6. Under certain conditions, for example, by increasing a radius at a corner from let us say 1/16" to 3/32", it might be possible to reduce the stress concentration factor at this corner from a very high to a relatively low value.

The final requirement which we listed was that of weldability. This is very important when it becomes necessary to make repairs on a finished or semi-finished mold. Here again the precipitation hardening steel has a distinct advantage over other types. This advantage is inherent in the metallurgy of the steel and results from the fact that the steel cannot harden excessively by quenching from high temperature. Thus, there is no hard zone in the heat affected area adjacent to the weld as invariably occurs with a martensitic steel such as the AISI 4130 or 6145 type. If a precipitation hardening steel is used for the welding rod and the mold is aged

(Please turn to page 58)

Southeastern Ohio

Visits Vanadium

Lester Dickson

The November meeting of the Southeastern Section of the Society of Plastics Engineers was held November 17, in the Pioneer Room of the Berwick Hotel.

Mr. Baker read off the names of the nominees for Directors to be elected for the coming year to replace outgoing directors.

The nominating committee nominated for National Directors, Paul Brill, Len Monoco and Paul Smith, and for Section Directors, Paul Cochran, Talmadge Scott, Sam Bazler, Howard Loeffelman and Lester Dickson.

The motion was made for nominations from the floor by Jack Knight and seconded by George Edwards.

Jack Stansel and John Ondrejko were nominated and seconded.

The meeting was turned over to the Program Chairman, Paul Brill who introduced the Speaker, Mr. Frank Isler, Plant Manager for the Vanadium Corporation, who gave a talk on the Vanadium Corp. and its operations in the Cambridge Plant.

Following his talk the Society was invited to attend a plant tour where they were guests of Mr. H. Rathman, Director of Process Engineering; Mr. T. Merrill, Director of Product Engineering; Mr. D. Zambrannen Asst. Plant Manager and Mr. T. Gross, Plant Metallurgist.

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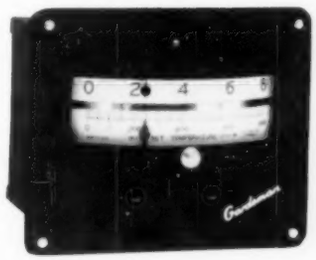

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Pyrogallol Reducing . . .

(Continued from page 36)

Banks and Upton recommended an 0.8% pyrogallol solution as the reducing agent, but gave no further details for its use. The process was primarily intended for use with electrotyping wax molds as used in the printing industry. The silver solution was made up of:

Silver nitrate	1.0%
Glycerol	15.0%
Gelatin	0.2%

Once a film of silver is deposited on the given surface it is transferred to an acid copper sulphate bath, given a "strike" of copper, and subsequently copper, nickel or other metals can be electrolytically deposited.

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Plastics—Paper . . .

(Continued from page 34)

Pulp Molding

The molding of pulp to make picnic plates and many paper mache articles is an old art. However, this art has now been extended by the development of processes for incorporating resins into the preformed pulp and then subjecting the preform to a final molding under heat and pressure. The resin may be incorporated by a beater addition technique or the preform can be saturated with resin solution or emulsion. The lessons learned from normal saturation and beater addition studies are directly applicable to pulp molding work. Many thermosetting and thermoplastic resins have been used for pulp molding with the phenolics predominating. Recently[2] a new resin has been developed on an experimental scale which shows promise for use in pulp molding. This is a benzoguanamine-formaldehyde resin which is similar to melamine but has a phenyl group in place of one of the amine groups. This has unlimited color possibilities as opposed to the phenolics and can be added as a fine slurry in water. Melamines and Ureas have not been extensively practiced as they retain considerable water solubility during the preforming period. Table V lists some comparative figures between the new resin and a phenolic pulp molding compound.

TABLE V

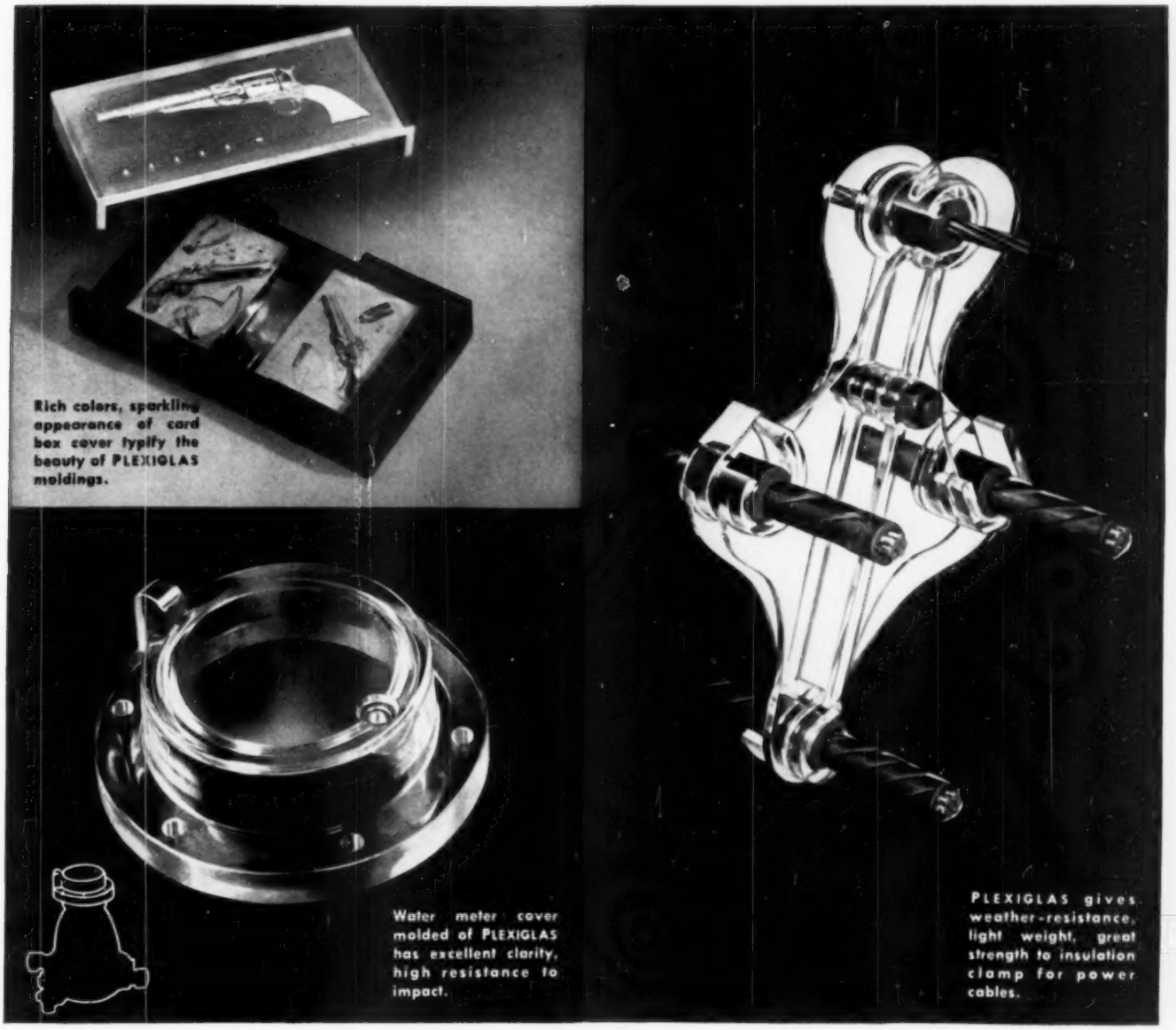
A comparison between Benzoguanamine and Phenolic Pulp Molding (condensed from reference 2.)

Property	Benzoguanamine	Phenolic
Resin Content, Percent	60	35-55
Color Possibilities	unlimited	dark colors only
Specific Gravity	1.5	1.33-1.40
Weight increase on soaking 24 hours, percent	0.8	0.4-1.5
Light Stability	excellent	yellows
Flexural Strength (mean) p.s.i.	14,500	16,000

2. R. Lindsenfelser, Tappi 36, 20A. (1953)

Conclusion

In a survey article of this kind only a brief reference can be made to the many developments in the fascinating field of paper-plastics combinations. Probably in no field of paper technology is there such developmental activity and as more and more plastics and plastics application techniques develop the number and variety of combinations with paper will also develop. There is no doubt in the minds of people active in this field that the next ten years will see even greater developments than those which have already taken place in the past postwar years.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Prehardened Mold Steels . . .

(Continued from page 55)

(or reaged) after welding, the deposited weld metal and adjacent areas of the mold will machine and polish like the rest of the mold, almost as though no welding had been done.

We feel that the prehardened mold steels, and particularly the precipitation hardening type, are of great potential benefit to the plastics molding industry. They have already proven their value in the injection molding field where they are now quite extensively used. There has been some reluctance to try them for compression and transfer molding applications because of the generally higher flash-land loads and the greater problems of abrasion and wash. It is reasonable to predict, however, that they will find increasing usage in these fields as more experience is gained with the steels under actual operating conditions, and as molds become larger or more complex in shape and therefore more of a problem to harden after machining.

Internal Pressure . . .

(Continued from page 28)

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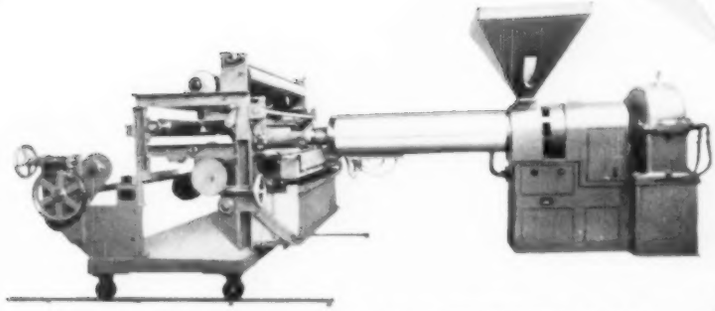

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